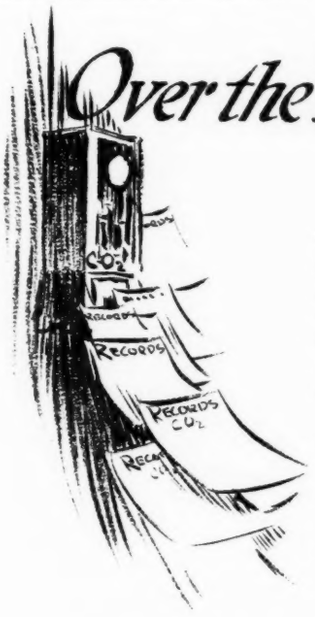
POWER

Volume 51 **New York, February 17, 1920** *Number 7*



Over the Top with the Boiler Room Crew

By Frankland Cheney

Jim Wright, the chief of the Porpoise Point Power Co., tamped the tobacco in his old corn cob, put his feet on the desk and tilted back his chair with a contented sigh. His visions of earthly joy, however, were soon interrupted, as the door slid open and in walked the boiler-room crew. A husky son of Erin seemed to be the acknowledged spokesman, and he was not long in making their mission known.

"Chief," said he, "we was thinking we would like to have a raise."

Jim looked them over for a second or two and decided the chances for a jolly were rather slim.

"Well, boys," he said, "I'll see what I can do and will let you know in a day or two."

The men thanked him and filed out of the engine room. Jim sat still for some minutes, wondering just what he was going to do. The Porpoise Point Power Co. was barely paying expenses and to increase the wages of the six men in the boiler room would bring a roar from the management that would put the turbines out of balance. But something had to be done.

As he straightened up in his chair, his eyes rested on the CO_2 machine in the corner of the engine room. This machine had been installed for more than a year, but somehow it had failed to come up to expectations. A bonus had been offered to the watch delivering the highest CO_2, but it had only created jealousy. No. 2 watch with a constant load had invariably won the money, and after the third week the others lost interest and refused to make an effort. Yet the chief realized that a raise would have to come through the medium of this machine.

The day was divided into three eight-hour shifts. No. 1 watch, from 12 to 8 p. m., had a light load. The furnaces were all thoroughly cleaned and clinkered, and it would be impossible to maintain any sort of CO_2 during this time. Watch No. 3 were on duty from 4 p. m. to midnight. The load on this run began to fall away around 8:30 and continued to drop until midnight, when it reached its minimum. This being the case, it was difficult to maintain a satisfactory CO_2 during the latter part of this run. The men of these two watches were efficient and capable and as worthy of consideration as those of watch No. 2, where a constant load made possible a very high CO_2 during the entire watch. A fireman and helper were on the boiler-room floor during each watch, and after considerable thought the chief tacked up the following notice:

Beginning the first of the week two bonuses will be regularly offered the boiler-room help. The first, a sum of nine dollars, to be equally divided among the firemen. The second, a sum of six dollars, to be equally divided among the helpers. The above amounts will be paid each week providing that the CO_2 for the entire week will average 10 per cent. The daily CO_2 charts will be measured by a planimeter for that purpose.

The boiler-room help read the notices, but did not appear to grow very enthusiastic. The chief waited for the idea to sink in and then summoned them. In a straight-from-the-shoulder talk he told them how the increasing cost of everything had affected the company; how the stockholders had received nothing on their investment for a year; how the light commissioners had refused to allow them to raise the rates. He also told them that he realized they were entitled to an increase in salary and if they were willing to do teamwork it could be squeezed out of the coal pile. He urged them to give his plan a trial, telling them if they would make an honest effort for two months and were still dissatisfied, he would make a fight for a straight raise all around.

The men were at first skeptical, but the earnestness of the chief's manner won them over and they finally agreed to give it a trial. The first two days the planimeter was put on the charts, it showed an average of less than 9; the third day it jumped to 10½; at the end of the week the average for the seven days was 10⅝.

In going over his back records the chief found the pounds of coal per kilowatt had been from 3.2 to 3.5 and the coal consumed each day had ranged from 59,000 to 64,000 lb. For the week just ended the highest rate had been 3.3, which was at least encouraging; but the attitude of the men themselves gave the most satisfaction. At the end of the first month the charts were averaging better than 12 per cent. The average cost per kilowatt at the board for the preceding month had been 0.017; for the month just ended it was 0.015. Here was something real, and the chief determined that they should not lose interest in their work. As the second month was drawing to a close, the old notices were replaced by new ones which read:

The weekly bonus to be equally divided among the firemen will be fifteen dollars. The helpers' bonus will be ten dollars. To earn the above reward the management expects a weekly average of 12 per cent CO_2.

And the end is not yet.

Model Small Ice Plant in Cuba

By J. KILIAN

ALTHOUGH the climate of Cuba is tropical, ice-making and refrigerating plants have not been introduced in the smaller communities of the Island as extensively as might be supposed. It is true that the capital city, Havana, has a number of large ice plants, but in the interior towns they are few and far between. However, where plants have been installed, invariably they have proved successful.

During the war the Vuelta Abajo district enjoyed a period of great prosperity due to the increased demand for tobacco and the high price obtained, and with improved conditions there arose a demand for ice in the City of Pinar del Rio, which is the capital of the province of the same name and the trade center of the tobacco-growing district. The matter was taken up by the Hidro Electrica Pinarena, and after investigation a raw-water plant of 12 tons daily capacity was decided upon as being of sufficient size for the city, which has a population of about 12,000.

In choosing a site, it was desired to locate the plant as near a source of water supply as possible, so the building was placed about 600 ft. from the river, which was as close as local conditions permitted. The building is of tile construction, one story high, faced with a smooth cement finish. It is designed along simple lines and presents a rather pleasing appearance. The hip is supported by wooden trusses resting on pilasters in the walls, with a row of columns through the center of the building for additional support. The floors are concrete throughout. There are no interior partitions in the manufacturing room and large windows provide ample light throughout. The manufacturing room is 76 ft. 9 in. long and 47 ft. 7 in. wide, inside measurements, by 16 ft. clear height under the trusses. The ice-storage room is 34 ft. 7 in. and 18 ft. 6 in. by 10 ft. high, and the shipping room is 18 ft. 6 in. and 11 ft. 6 in. by 10 ft. high. The building is laid out with a view to doubling the capacity of the plant in the future, space being provided for duplication of all equipment.

The ice tank is insulated with pure sheet cork for the bottom, the sides and ends being insulated with granulated cork. The ice-storage room is lined with pure sheet cork plastered with portland cement. This room is maintained at a temperature of about 28 deg. F. by means of 500 ft. of 2-in. ammonia evaporating piping. This piping is connected to the ice-making compressor and also to a small vertical compressor provided to maintain the temperature when the ice plant is not in operation.

In the ice tank are 180 standard 300-lb. cans in which a remarkably fine quality of clear ice is obtained from the river water by means of a low-pressure air agitating system and a water softener. The latter is necessary to eliminate the objectionable mineral salts present in the river water used. The ice tank is 35 ft. long by 16 ft. 3 in. wide. A temperature of 16 deg. F. is maintained by ammonia evaporating piping immersed in brine. Brine circulation is effected by a 20-in. horizontal propeller and a suitable tank partition.

From the river, 600 ft. distant, the water is pumped into a 15,000-gal. storage tank by a 70-g.p.m. electrically operated pump, and from the tank it is distributed to the ammonia condenser, water softener, etc., as required. The tank is always kept filled, providing a four-hour reserve supply in case of stoppage of the pump.

All the machinery, with the exception of the small compressor, is motor-driven, polyphase low-tension current being used. The motors are of Swedish manufacture and were secured out of dealers' stocks in Havana, it being next to impossible to obtain shipment of American motors. The main motor driving the compressor is of the slip-ring induction type, 580 r.p.m., and drives the compressor at 100 r.p.m. through a double leather belt. The smaller motors driving the auxiliaries are of the squirrel-cage type. The small compressor is driven by a 5-hp. oil engine, an independent source of power for this service being considered advisable.

The water softener is of the intermittent type, the continuous type being impractical in this case, owing to the water supply varying in quality. This apparatus treats a definite quantity of water with a definite charge of chemicals. It consists of two treating tanks and a chemical tank with necessary connections. While one tank is treating the water to be softened, water which has already been treated is used from the other for ice-making purposes. Each tank is 7 ft. diameter by 6 ft. high, the whole equipment being mounted on a platform in the machine room. Hydrated lime and soda ash are the chemicals used. The lime precipitates the calcium and magnesium bicarbonates in the water by chemically combining with the free and half-bound carbon dioxide gas, and converts them to carbonates. The soda ash reacts with the magnesium sulphates and forms magnesium carbonate and sodium sulphate, the whole being precipitated as insoluble sludge to the bottom of the tank. The treated water is removed from the tanks by means of a floating pipe which receives the water from near the surface.

No expense was spared to make the plant as nearly perfect and permanent as possible, and the ice produced is the finest to be seen anywhere in Cuba. The plans were prepared for the Hidro Electrica Pinarena by Lombard & Co., Havana, and the entire installation was made under their supervision. While no speed records were made in the building and equipment of the plant, its complete erection was accomplished in a reasonable length of time, and in the face of conditions, due to the world war, which seemed almost insurmountable.

PRINCIPAL EQUIPMENT OF HYDRO-ELECTRIC PINARENA ICE PLANT

Equipment	Kind	Size	Use	Operating Conditions	Maker
1 Compressor	Simple, double-acting	8½ x 16 in.	Ice-making and cold storage	Motor-driven, 100 r.p.m.	Vilter Manufacturing Co.
1 Compressor	Vertical, single-acting	4 x 6 in.	Cold storage	Oil-engine driven, 200 r.p.m.	Vilter Manufacturing Co.
1 Condenser	Double-pipe	3 stands, 12 p.h.	Condense ammonia vapor.		Vilter Manufacturing Co.
1 Ice tank	Steel	35 x 16.25 x 4 ft.	Ice making	Ammonia evaporating pipe in brine	Vilter Manufacturing Co.
1 Air-agitating System	Low-pressure	100 cu. ft. free air per min. at 3 lb.	Agitating water in ice cans	Blower motor-driven	Vilter Manufacturing Co.
1 Water softener	Intermittent	210 gal. per hr.	Water purification	Precipitation by lime and soda ash	Wm. Graver Tank Works
1 Motor	Slip-ring	50 hp.	Drive large compressor	Polyphase, low-tension, 580 r.p.m.	Allmänna Svenska Electriska Aktiebolaget Västeras, Sweden
1 Motor	Squirrel-cage	5 hp.	Drive propeller and core pump	Polyphase, low-tension, 940 r.p.m.	
1 Motor	Squirrel-cage	5 hp.	Drive blower	Polyphase, low-tension, 1420 r.p.m.	
1 Oil engine	Vertical	5 hp.	Drive small compressor	Intermittent, 300 r.p.m.	Bolinder, Sweden

FIG. 1 - SHOWING PLEASING ARCHITECTURE OF THE PLANT

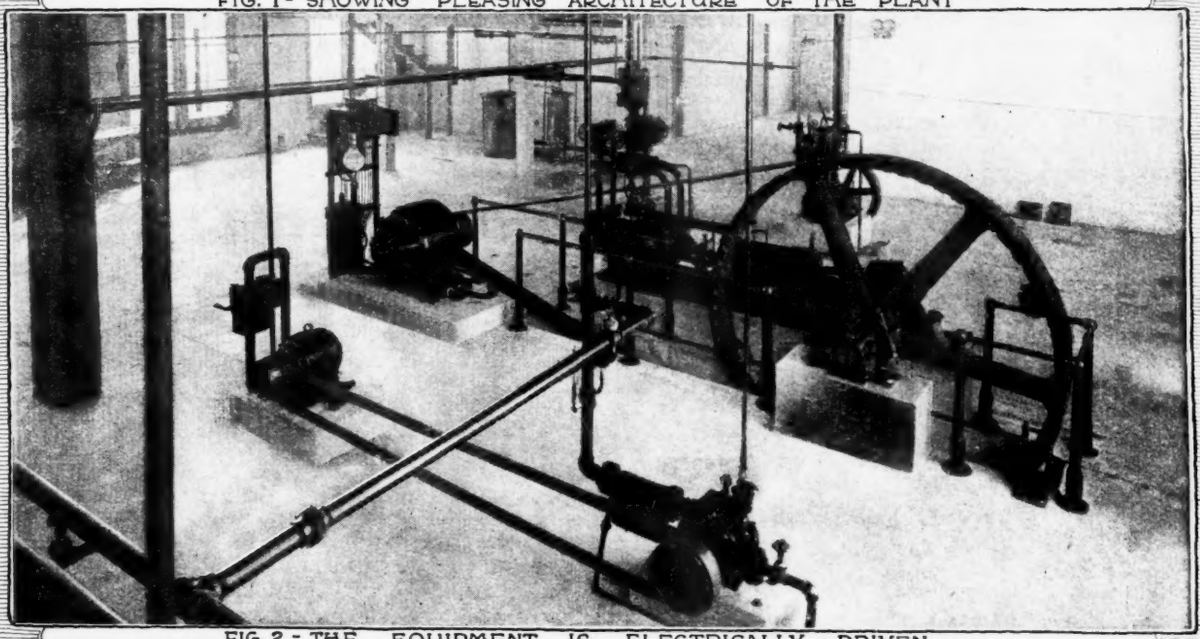


FIG. 2 - THE EQUIPMENT IS ELECTRICALLY DRIVEN

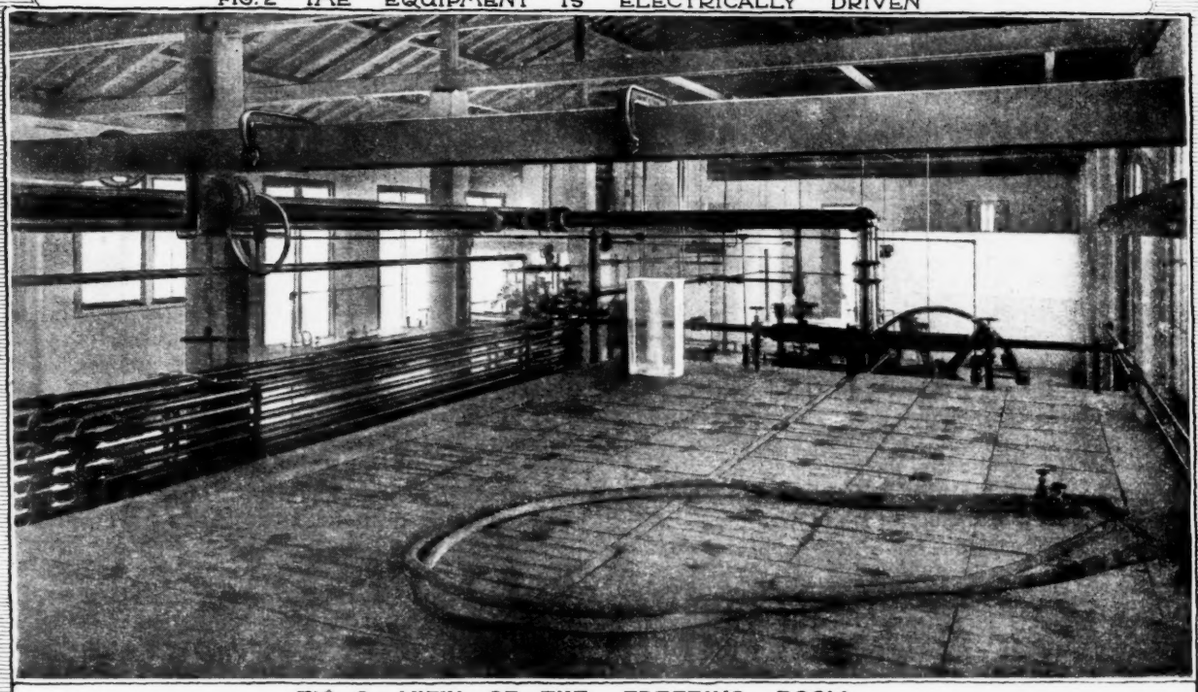


FIG. 3 - VIEW OF THE FREEZING ROOM

Drying Out a Generator, Switchboard and Motors After a Flood

By KENNETH A. REED

DURING the flood through the Ohio and Indiana district, some years ago, a large number of power plants were flooded, and in many cases generators, motors and switchboards were under water for a week or longer. Before the water had subsided, practically all of the large manufacturers had gotten every available engineer lined up awaiting the call from their customers for assistance in getting these plants back into commission. Such assignments were not enviable ones by any means. Many animals—such as cats, dogs, rats, etc.—had been drowned in the buildings, and the sewers had filled the basements with refuse, so that the air was very foul and injurious.

The work to which I was assigned consisted of drying out a small direct-current engine-type generator, several motors, and the switchboard and cables of a plant. Upon looking the job over, I found that the apparatus, which was in a basement, had been entirely under water for several days, and the basement floor was still covered with about a foot of water and six inches of mud and slime. There was no outside source of power for drying out the generator electrically, owing to the fact that the city light plant had also been flooded. The customer's boiler room was on the same level as the power plant, therefore it was impossible to raise steam to run the engine and dry out the generator by the short-circuit method. It then became necessary to devise original means whereby the necessary heat could be produced and properly applied. After discarding several schemes, it was decided to build a corrugated sheet-iron house around the entire engine and generator, and place two wood-burning stoves inside, with openings made in the walls of the house for supplying fuel to the stoves. This was an entirely feasible method, inasmuch as the floor of the engine room was concrete; and it had the additional advantage of providing room for drying one motor, thereby greatly facilitating the total time required to dry out all the apparatus. Fig. 1 shows the general plan of the layout. The openings formed by the corrugations were sufficient to allow the moisture to escape from the box.

After completing the house and drilling holes in the top for the insertion of thermometers, fires were built and the temperature inside raised to about 90 deg. C. Arrangements were made for a night fireman, who was required to record the temperature readings every half hour, to avoid overheating and damage to the apparatus. Practically constant temperature was maintained in this housing for about five days and nights.

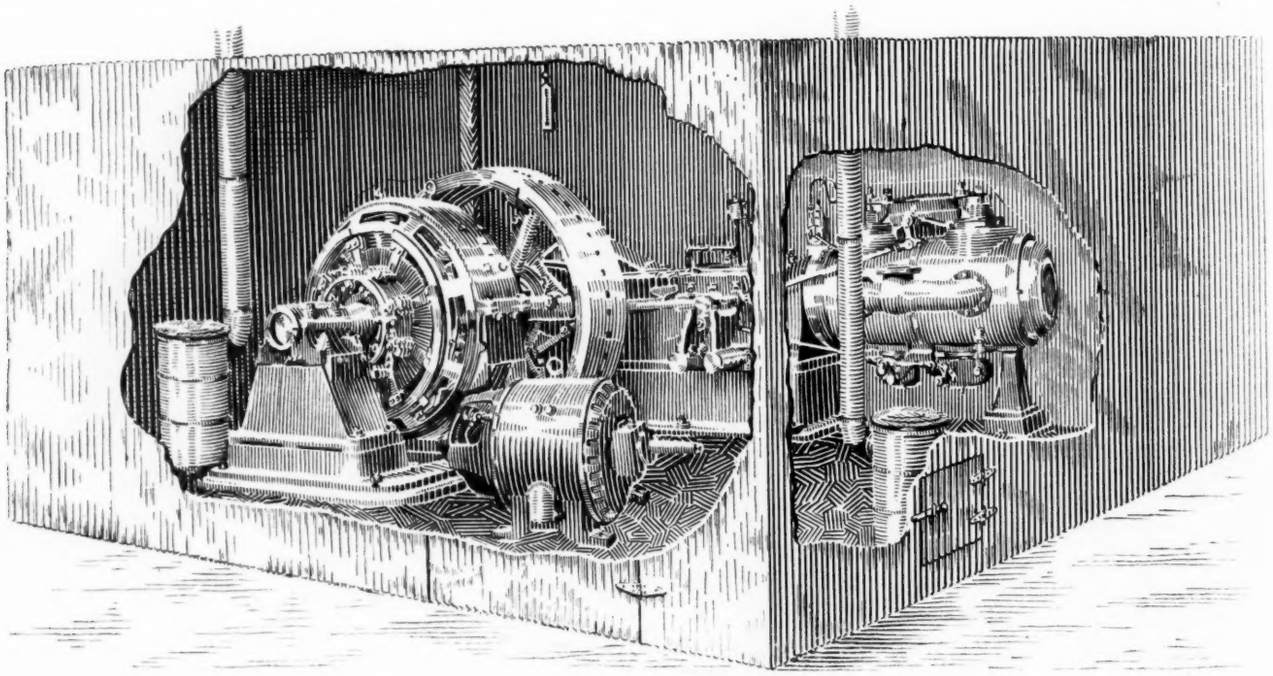


FIG. 1. IRON BOX AND ARRANGEMENT OF EQUIPMENT INSIDE FOR DRYING

At the end of this time the generator was fairly dry excepting for some excessive dampness inside the commutator. During this time, however, all the motors in the plant had been dried out by placing them one at a time in the oven with the generator, the drying of the motors of course proceeding much faster than that of the generator, because of the great difference in size.

Since the commutator moisture was inside the V-rings, external heat did not seem to have much effect on eliminating it, and heating the commutator itself was decided upon. This was done by running the generator with the shunt field disconnected and the armature short-circuited through the series winding, causing a heavy current to flow and generating a large amount of heat at the commutator. The voltage under these conditions was very low, consequently there was no danger of the machine breaking down to ground. However, in order to avoid generating sufficient current to damage the armature coils, a portable ammeter

was placed in the circuit, as in Fig. 2, and the current kept at a safe value by throttling the engine. Blowtorches were applied to the commutator, and after short-circuit operation for about a day and a half, the machine was considered to be in serviceable condition.

While the generator and motors were being dried out, the switchboard was stripped of all equipment, including the switches, instruments, circuit-breakers, etc., after which the panels were washed and the iron framework given a coat of paint. The field rheostat was

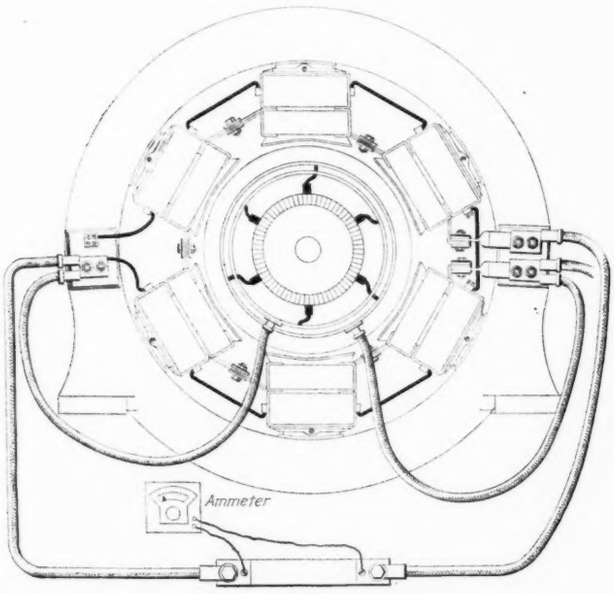


FIG. 2. ARMATURE SHORT-CIRCUITED THROUGH SERIES-FIELD WINDING

cleaned of mud and slime and placed on top of the oven over the generator to dry. Upon taking the covers off the meters, it was found that they were damaged beyond repair in the plant, and it was therefore necessary to return them to the manufacturer. The circuit-breakers were also badly damaged, but we were able to put them in shape for operation, and after cleaning and polishing the switches and busbar copper, the board was reassembled in practically new condition.

The cable ducts were, of course, full of water, and when the cable was pulled out the insulation was found to have deteriorated to such an extent that it would not stand being pulled back into the ducts after drying. New cable could not be secured locally, and in order to avoid delay in starting up the plant, the old cable was run across the floor on boards. The customer was advised to purchase lead-covered cable for the new leads, for no matter how much we might swab and dry out the duct lines, there would remain under the floor for a very long time a considerable amount of dampness, which would have proved very detrimental to braid-covered cable.

All the details having been completed, the machine was brought up to speed and the voltage gradually raised. Before reaching normal voltage, however, severe sparking developed in the form of glowing fire around the entire commutator. This, obviously, was due to short-circuits between bars, and when the machine was shut down such was found to be the case. About twenty places were discovered where the mica had been oil-soaked, but not bad enough to break down until after it had been under water. These places were carefully cleaned out until good clear mica was reached and then filled with dentists' cement, which sets very quickly. No further trouble was experienced in securing normal voltage, which was ascertained by means of a portable voltmeter borrowed from the city light plant. No-load and full-load voltage points were marked on the field rheostat, as there was no other means of determining the voltage until the instruments were received from the manufacturer, except by using judgment as to the brilliancy of the lights. Full load was put on the machine the following day, and all the apparatus operated satisfactorily. Nothing remained to be done except to mount the meters and install the cable when received.

Losses in Belt Transmission

By Charles H. Herter

Regarding the loss of power occasioned by having driving belts either slipping or tightened too much, tests enable the writer to qualify statements that the loss through slip, under ordinary conditions, ranges from a minimum of 5 to more than 15 per cent. If 5 per cent. and more was the loss suffered normally in a belt drive, leather belting would not be tolerated in an efficient power plant. Many examples can be cited where the loss in speed change from one shaft to the other does not exceed 1.1 per cent., creep and slip included. Whenever the combined loss exceeds 2 per cent., there is something wrong with the drive. So many misleading horsepower formulas exist for belt transmission that in many cases insufficient width of belting is provided, compelling the user to resort to excessive tightening to get the work done. To correct this evil wide-awake leather belt manufacturers now furnish expert advice gratis to intending purchasers.

Occasionally, one is called in to find a remedy where the speed loss is great enough to be disclosed by a corresponding loss in production. On a wire-cloth loom the slippage was found to be 4 per cent., causing the mesh to be irregular, the tension of the stiff canvas belt fluctuating with the hygrometric condition of the atmosphere. A good waterproof leather belt solved the problem. In a chocolate factory with an old three-ply leather belt 23 in. wide, the slippage reached 12 per cent. This was remedied by cleaning it and running a 16-in. heavy double belt independently on top of it. In an ice factory a 125-ton ammonia compressor with an old 30-in. double leather belt, saturated with oil, ran at 46 r.p.m. when it should have made 56 r.p.m. The loss was nearly 18 per cent., equivalent to $70 worth of ice per day. This was remedied by putting on a new belt. The belt efficiency of an identical unit alongside was found to be 98.8 per cent.

A simple way for checking the performance of a drive is to ascertain the loss in speed from the driving shaft to the driven shaft. Suppose we have an air compressor driven by belt from a constant-speed induction motor, diameter of compressor belt wheel, 50 in.; of motor pulley, 10 in.; speed of motor, according to name plate, 1,170 r.p.m., but with an accurate tachometer or speed counter we find it to be 1,230 r.p.m. at the time of test. The belt used is ¼ in. thick. Under favorable conditions and with sufficient width of leather belt, the speed of air compressor should be equal to $1230 \times \frac{10.25}{50.25} = 251$ r.p.m., which multiplied by 0.988 to allow for creep and slip equals 248 r.p.m. net. If, by actual count, the speed of the compressor is found to be only 241 r.p.m., the speed loss is $\frac{10}{251}$, or 3.98 per cent., showing that the belt is in poor condition, or probably not large enough for the power required. A flexible idler properly placed will rectify the trouble and avoid the

need of excessive tension. A thicker belt is not advisable because it would not wrap well around the small pulley, the outer ply would be overstretched, its circumference being appreciably greater than that of the pulley. It would be hard on the cement, which is expected to hold the two plies together. For this reason it is good practice to have a belt no thicker than 2 or, at most, 3 per cent. of the diameter of the smallest pulley used with it.

In calculating the speed change from one shaft to another it is necessary to figure always from the driver to the driven, and to add one belt thickness to each diameter.

For example, a 4-in. motor pulley at 1000 r.p.m. will drive a 40-in. pulley at what speed? 100 r.p.m.? No. If the belt is 0.25 in. thick, we have

$$\frac{4.25\ in. \times 1000\ r.p.m.}{40.25\ in.} = 105.6\ r.p.m.$$

If the 40-in. diameter pulley is driving at 100 r.p.m., will the speed of the 4-in. driven pulley be 1000 r.p.m.? No. It will be

$$\frac{40.25\ in. \times 100\ r.p.m.}{4.25\ in.} = 947.05\ r.p.m.$$

The pulleys are of the same size in both cases. In the first case, where the speed is being reduced, the slip may be 2 per cent., giving a true speed of $105.6 \times 0.98 =$ 103.5 r.p.m., while in the second case the slip may be 1 per cent., the elongation of the belt while on the 40-in. driving pulley being less than on the 4-in. pulley because of its greater leverage and grip. Therefore the true speed of the 4-in. driven pulley will be about $947 \times 0.99 =$ 937 r.p.m.

One writer (Mr. Engler) in *Power* of July 8, 1919, cites an unusual case with a 4-in. double leather belt driving a fan. He says it was at first so tight that the power input was equivalent to $\frac{22\ amp. \times 440\ volts}{746}$ $= 12.98$ hp. With a supposed 6-in. diameter motor pulley at 1200 r.p.m. the rim velocity is 6 in. $\times$ 0.2618 $\times$ 1,200 = 1,885 ft. per min. The pull per inch width of belt would therefore be $\frac{12.98 \times 33{,}000}{1{,}885\ ft. \times 4\ in.} = 56.8$ lb.

One is astonished to learn that, "with this high tension on the belt the loss through slip was from 7 to 12 per cent." The belt must have been oily and slippery. After it had been put in better condition, it was found to do its work with a power input equivalent to only $\frac{9.1\ amp. \times 440\ volts}{746} = 5.37$ hp., which is but 41.4 per cent. of the power previously expended. Thus the pull per inch width of double belt dropped to 56.8×0.414, or to 23.52 lb., and still "the slip under these conditions was from 2 to 5 per cent."

(The use of the factor $0.2618 = \frac{\pi}{12}$ saves multiplying by 3.1416 and then dividing by 12 to find velocity in feet per minute.)

These observations are rather at variance with those made by others who find that by keeping the excess tension down to 40 lb. with single belts, or 60 lb. with double leather belts, the loss by creep and slip does not exceed 1 per cent.

In transmitting 5.37 hp., the number of feet of double belt 1 in. wide per minute per horsepower figures out, for the motor pulley assumed,

$$\frac{1885\ ft. \times 4\ in.\ double}{5.37\ hp.} = 1{,}404\ ft.$$

which certainly is sufficient leather to secure an efficiency of 99 per cent. if the belt is in normal condition. In every plant there is a possibility of losses being suffered in the transmission of power by belting, but there is no excuse for permitting such losses to continue. By simply comparing the actual speed change of two shafts with the calculated speed change as indicated above, the efficiency of the drive can be easily determined and brought up to 98 or 99 per cent. Thus a substantial saving can be effected at a slight expense, because properly proportioned leather belt drives give satisfactory service for periods of ten to forty years.

It is remarkable how well the advocates of direct-connected motors and prime movers have succeeded in creating a wide impression that belt drives are only about 85 per cent. efficient. To cite but one convenient example, in a paper "The Oil Engineer for Ice Plant Service," read at the International Engineering Congress, San Francisco, September, 1915, and printed in the *Journal* of American Society of Refrigerating Engineers, September, 1915, page 38, it is recommended that the efficiency of the belt or rope drive be taken at 85 per cent. In reality, with rational design, using sufficient surface, speed and leather, the efficiency of a single drive can be made 97 to 99 per cent.

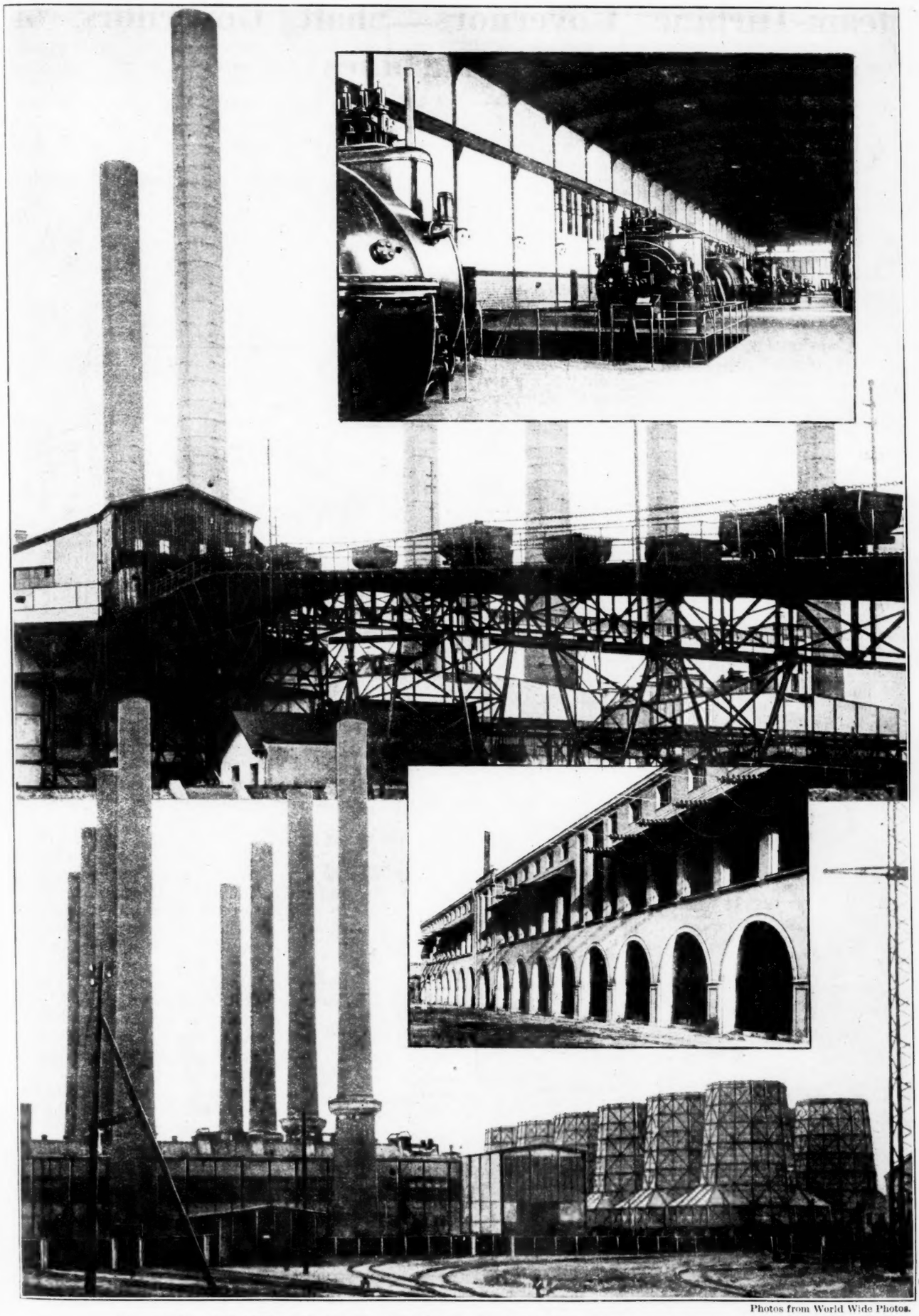
Power Plant Built in Germany During the War

The photographs on the opposite page are of a 128,000-kva. steam-power plant built in the village of Zoschovnewitz-Golpa, near Bitterfield, in Prussian Saxony, 75 miles southwest from Berlin. This plant is in the center of the lignite district and was put in operation in the fall of 1918. At present it is supplying 50,000 kva. to Berlin, but as soon as the necessary transmission lines are completed the load will be increased to near the plant's capacity.

In the generator room, upper right-hand corner, are eight 16,000-kva. steam-turbine driven alternators, supplied with steam from 64 boilers. Draft for the boilers is obtained from eight stacks 325 feet high. Coal is obtained from the Golpa mine, near the plant, by an automatic system of cars, as shown in the figure across the center of the page. The arrangement of the turbines in the power plant differs from American practice in that the machines are placed end to end down the center of the turbine room, while in American plants they are usually placed crosswise. The frustum-shaped towers, to the right in the bottom figure, are evidently cooling towers for the circulating water. The German government in line with the plans for the socialization of the electric industry has taken over the stock of the company that built this plant.

Exports of American coal in much greater quantity than has been anticipated is expected to result from the determination of Denmark and Sweden to divert important portions of their tonnage to the American coal trade. This action on the part of two of the European countries is thought to be the forerunner of similar action by others. The Shipping Board recently called attention to the tendency on the part of some European countries to keep their shipping in profitable trade routes despite the dire need in Europe for coal supply.

During the entire winter, it is stated by Shipping Board officials, the vessels in the New England coal trade have been operated at a loss. In order to make this service self-sustaining an increase of 75c. per ton in the coal rates from Hampton Roads and Baltimore to Boston and other New England ports has been put into effect. The increased rates will permit of no profit on these vessels, it is said.



Photos from World Wide Photos.

EXTERIOR AND INTERIOR VIEWS OF POWER-PLANT NEAR BITTERFIELD, PRUSSIAN SAXONY

Steam-Turbine Governors—Shaft Governors of Terry Turbines

Describes the shaft governor, emergency governor and governor valves used on the Terry turbine. Directions are given for their adjustment and care.

ALTHOUGH the Terry Turbine is built in many sizes, the general design of the governing mechanism employed is the same. Greater powers required for the larger frames make it necessary to use larger parts throughout, but its design is not altered. The shaft governor is of the usual flyball type and is mounted on the end of the turbine shaft as shown in Fig. 1. The detail structure of the governor itself is shown diagrammatically in Fig. 2. Under the action of centrifugal force the governor weights *A* tend to separate. Rocking about the knife-edges *B* the weights push against the governor slide *J*, which is a movable member inserted in the end of the hollow shaft. Its motion is resisted by the main governor spring *C* acting against the governor spring yoke *H*, the yoke passing through milled slots in the shaft and acting against a hardened steel pin. The motion of the governor slide *J* is transmitted through a ball or ball race to a lever or series of levers which operate the governor valve. The governor slide *J* is protected against wear from the governor weights by a hardened steel shoe, which is secured by the governor yoke pin. An adjusting nut *G* is provided to vary the compression of the spring *C*.

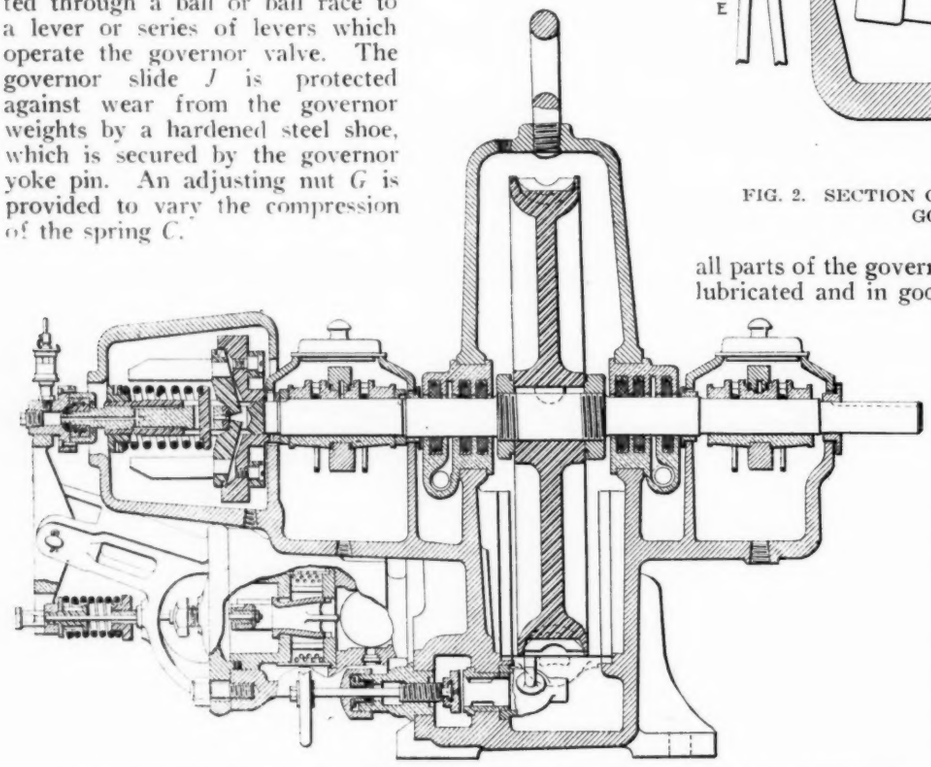


FIG. 1. SECTION OF TERRY TURBINE SHOWING STANDARD FORM OF GOVERNOR AND GOVERNOR VALVE

By altering the adjusting nut *G* a change of speed may be obtained—tightening the nut increasing the speed, slacking it off decreasing it. Adjustment from the nut *G* is only designed to alter the speed within the range of the governor capacity, as greater changes in speed would be liable to tax the governor weights and spring beyond their safe limit of strength. To obtain greater changes in speed, it is therefore necessary to procure heavier or lighter weights with the corresponding strength of spring. These may be obtained from the builder. After making adjustments, it is necessary to move the governor spring yoke *H* back to a central position so that it does not rub on the shaft.

Most governor troubles can be avoided by keeping

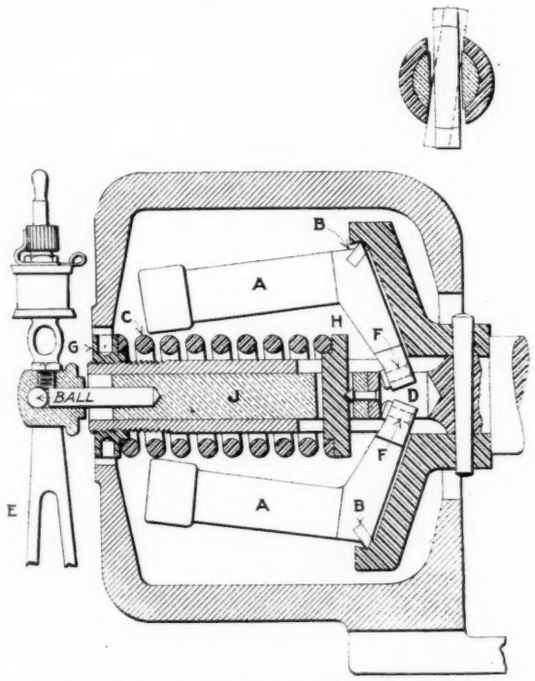


FIG. 2. SECTION OF SMALL TERRY SHAFT GOVERNOR

all parts of the governing mechanism clean, properly lubricated and in good adjustment. When troubles occur, they can usually be classified as overspeeding or as hunting (periodic speed fluctuations). Hunting may be produced by improper valve setting or by sticking or lost motion in some part of the governor mechanism. There is a spring provided to take up lost motion in the governor mechanism, marked "Governor Valve Spring" on Fig. 5, which may be tightened by turning the "Lower Valve Spring Seat," shown in the same figure. Sticking in the valve or stem may easily be detected by pushing in on the valve stem and observing if it moves steadily. The valve-stem spring should readily pull the valve out again. A sticking valve or stem may be caused by a bruise or a bend in the stem, too tight valve-stem packing, the presence of rust or scale on the valve itself, or misalignment between the valve and the governor lever. The corrections for these difficulties are obvious. Sticking in the governor is usually produced by a gummy slide or by the rubbing of the governor-spring yoke against the shaft. A thorough cleaning with kerosene

will usually eliminate the difficulty. If, when running at very light loads with all the jets open, the governor valve has a tendency to draw shut, the governor-valve spring shown in Fig. 5 should be tightened. Overspeeding at very light loads is caused by a poorly set

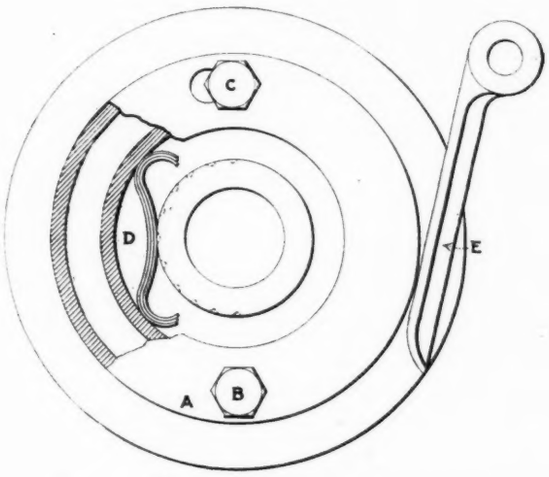


FIG. 3. TERRY EMERGENCY GOVERNOR

or a leaky valve. The setting of the valve will be explained later.

Terry emergency governors are usually set to shut off the steam to the turbine when the speed reaches about 10 per cent. above the operating rate. The form of emergency governor used on smaller Terry turbines is called the ring type, which is shown in Fig. 3. The ring *A* mounted on the back of the governor disk is pivoted at *B* and is limited in its movement by the stud

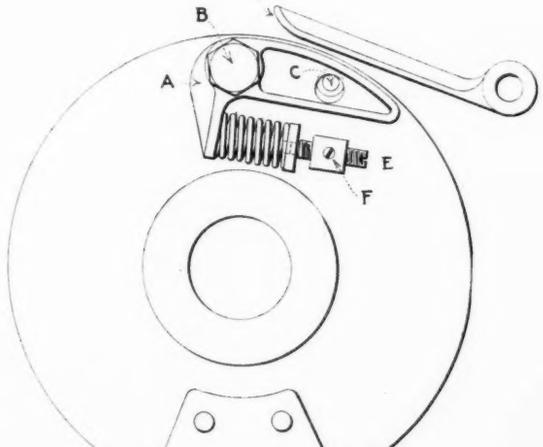


FIG. 4. ANOTHER TYPE OF TERRY EMERGENCY GOVERNOR

C. Normally, the ring is held concentric against the stud *C* by the spring *D*. As the ring is slightly unbalanced, centrifugal force tends to make it run eccentric. When the centrifugal force becomes great enough to overcome the compression of the spring *D*, the ring flies out to the limit of its travel and runs eccentric, hitting the trigger *E*, which closes the emergency valve.

The spring is held in position by a projection at the center which rests in one of the holes (shown dotted) on the hub of the governor disk. To lower the speed at which the emergency governor will operate, move the spring toward the pivot *B* with a screwdriver, and to increase the speed move it away from the pivot.

Another type of emergency governor is shown in Fig. 4. A lever *A* is pivoted on the stud *B* and is limited in its movement by a pin placed at the point *C*. This pin has about $\frac{3}{16}$ in. clearance. When the speed becomes high enough, the centrifugal force overcomes the pressure of the spring and the lever *A* flies out, striking the trigger *D*, which closes the emergency governor

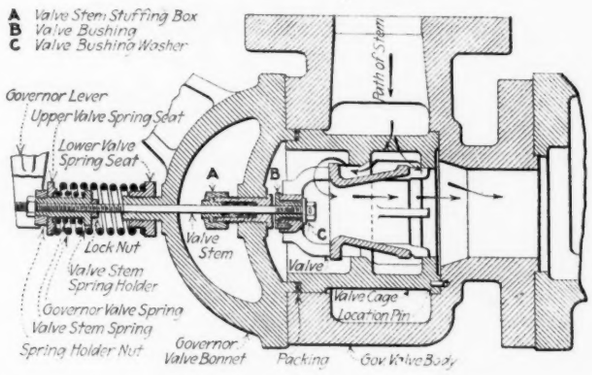


FIG. 5. STANDARD TYPE OF TERRY GOVERNOR VALVE

valve. This governor may be adjusted by altering the pressure of the spring with the adjusting screw *E*. A setscrew *F* is provided to lock the adjusting screw.

Emergency valves are of the butterfly type and are operated by a strong spring when released by the emergency governor. It is important that the packing in the stuffing-box be well lubricated and the stem always free to move.

Once a week, if the turbine is shut down that often, trip the emergency governor by hand. The turbine should stop or slow down considerably with the throttle

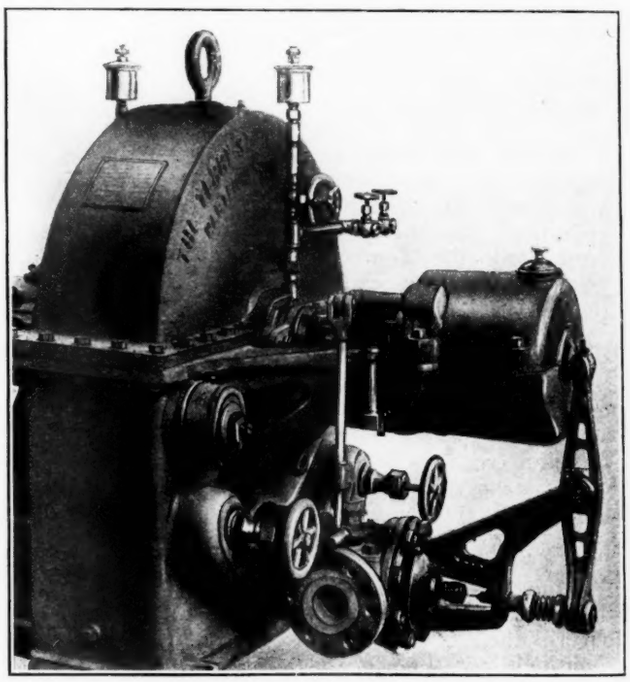


FIG. 6. THE TERRY SHAFT GOVERNOR

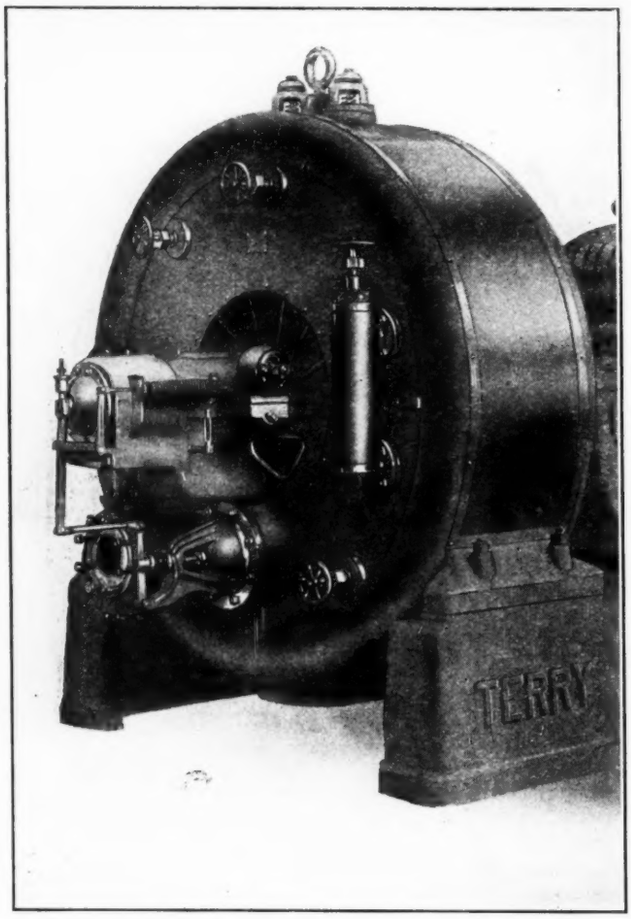


FIG. 7. ANOTHER FORM OF TERRY SHAFT GOVERNOR

wide open. The trigger should clear the governor lever *A*, Fig. 4, or ring *A*, Fig. 3, by not more than $\frac{1}{16}$ in. when the turbine is turned over by hand.

The governor valve now used on all Terry turbines is known as the bushing type (see Fig. 5). The construction is such that it permits removal of the valve and seats for inspection or repairs without removing the steam connections. A strainer is always supplied to prevent solid matter from injuring the turbine nozzles and wheel. Its principle of operation can be readily seen from the figure and needs no further explanation.

All Terry governor valves should be so adjusted that their maximum travel is one-eighth of the valve diameter; that is, a 3-in. valve should have a $\frac{3}{8}$-in. maximum opening. To check this travel, push in on the valve stem until the valve seats when the turbine is not running. Make a mark on the valve stem opposite the edge of the stuffing-box nut, then pull out on the stem as far as the governor mechanism will permit and make another mark on the valve stem opposite the stuffing-box nut. The distance between these marks gives the valve opening and may be adjusted by turning the valve-stem in the valve-stem spring holder, being sure to readjust the locknuts at each end of the spring holder. Always be sure that the governor valve closes tight when the governor weights are all the way out. This is important with any governor.

The general appearance of a Terry shaft governor is shown in Fig. 6, and a small turbine for generator drive with motor connection to the governor for independent speed control is shown in Fig. 7.

Governing Turbine-Driven Pump

Turbine-driven centrifugal pumps, particularly for boiler feed, such as Fig. 8, are widely used. The governor valve is on the steam line to the turbine, is actuated by the pressure in the pump discharge line, and acts on the turbine as a throttling governor. In addition, the turbine is provided with the usual flyball governor, which is set for higher than maximum normal pressure. This protects the turbine against overspeed.

By a ruling of the Industrial Board, Department of Labor and Industry, Commonwealth of Pennsylvania, Harrisburg, Penn., adopted Jan. 13, 1920, and operative Feb. 12, 1920, no person shall be allowed to carry matches or other flame-producing device into any workroom or other portion of a building wherein people are employed and where ether is manufactured, rectified or handled daily in quantities exceeding one-half gallon. In such places where there is a possibility of ether vapor being present, electrical or other apparatus, such as switches, motors, etc., capable of giving off sparks, shall not be permitted. Electric lighting systems shall be placed in conduits with vapor-proof globes. Open flames of any kind shall also be prohibited.

It is estimated that the output of the central stations in the United States in 1919 was approximately 30,300,000 kw.-hr. The total revenue is estimated at approximately $601,000,000. This is an increase of 2.1 per cent in output and 13 per cent in income over 1918.

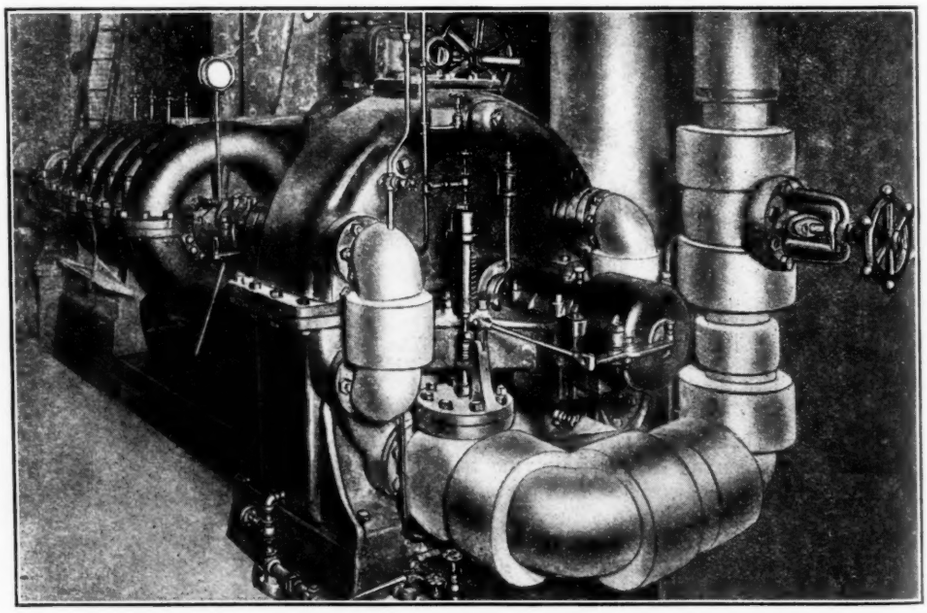


FIG. 8. STEAM TO TURBINE GOVERNED BY FEED-WATER PUMP GOVERNOR

Standard Meter Rates—Demand Rates

By LeROY W. ALLISON

This is the third and last of three articles on standard rate forms and deals with the second group of standard rate forms, known as demand rates. Four different standard demand-rate systems are discussed. Examples are given to show how these rates are applied in calculating bills.

UNDER the subject of "demand rates," there are four different standard rate systems in general use, these being (1) flat demand rate, (2) Wright demand rate, (3) Hopkinson demand rate, and (4) Doherty, or three-charge rate. These will be considered in the order noted. As mentioned in a previous article, the definitions given are those as approved by the Rate Research Committee of the National Electric Light Association. The term "demand rate" is applicable to any method of charge for electric service that is based on the maximum demand during a given period of time. The demand is expressed in such units as kilowatts or horsepower. Maximum-demand indicators or graphic meters are used. The demand rate has its basis in the customers' installations or maximum requirements in a certain period of time. It deals with the matter of connected load on the job.

Flat Demand Rate

The term "flat demand rate" is applicable to any method of charge for electric service that is based on the consumer's installation of energy-consuming devices, or on a fixed sum per customer. This rate is usually arranged on a basis of so much per watt or kilowatt, per month or for a longer term. Again, this type of rate is developed frequently at so much per consumer per month or per year, segregating the different classes of consumers into unit groups, each group covering a certain character and extent of service. The estimated demand, or the quantity of electric energy to be used, is an important consideration in the establishment of the flat rates. No meters are used.

The history of the flat-rate charge system dates back to the beginning of commercial electric service, for the first rates were arranged on this basis. For house and residence service a certain charge was made per 16-candlepower lamp per month, varying in different localities, as 40, 50 and 60 cents, and with minimum bill to be one dollar. As to be expected, many difficulties were encountered in the use of this type of rate in a general way. Careless people would allow their lights to burn continuously and beyond the point of needed utility; dishonest persons would burn more lamps than entitled to under their contract with the utility company; while in the matter of motor and other industrial service, like conditions prevailed. The fundamentals of operation dealt with the consumer being thoroughly fair and honest, but this wasn't always so.

Thus, when meters were introduced, the employment of flat rates decreased, and for a number of years they were almost in discard. The flat demand rate, however, is now regaining considerable popularity and is being used particularly for small consumers, such as residence and similar service. The type of rate makes it applicable to modification with the use of the "step" or "block" method of computation, as discussed in the issue of Feb. 10. A typical schedule from under the flat demand rate would be worked out along the following lines: $1 per month for each 50 watts of installation connected, applying primarily to small consumption; $30 per year for each horsepower of connected load; $45 per year per kilowatt for each of the first 25 kw. of maximum demand; $35 per year per kilowatt for each kilowatt in excess of 25.

Taking a typical example to show the method of calculating, assume that a consumer has a connected load of 400 watts. Under the flat rate of $1 per month for each 50 watts of installation connected, the monthly charge would be

$$\frac{400 \times \$1}{50} = \$8$$

Considering another instance, assume a maximum demand of 50 kw. per year for an installation, on the basis of $45 and $35, previously noted. This would work out

25	× 45 =	$1,125.00
25	× 35 =	875.00
Yearly total		$2,000.00

An example of a modification of the flat demand rate by the use of the "step" system is afforded in the present plan of lighting service of a Middle West central station. The basis of operation is as follows: For the first 30 hours' use of the customer's demand, a charge of 8c. net per kilowatt-hour; for the next 60 hours' use of the customer's demand, a charge of 6c. net per kilowatt-hour; for all further use of the customer's demand, the rate is 3c. per kilowatt-hour.

The customer's demand is based on the number of lamp outlets, the first 10 lamp outlets being rated at 30 watts each, the next 20 lamp outlets at 20 watts each, and all other outlets at 10 watts each. An an illustration, the demand for a house with 35 lamp outlets would be 750 watts, and if 100 hours' use was made of this demand, the total charge would be as follows:

Hours' Use		Watts Demand		Kw.		Cents Per Kw.-Hr.	Total
30	×	750	=	22.5	at	8	$1.70
60	×	750	=	45.0	at	6	2.70
10	×	750	=	7.5	at	3	0.225
Total 100				75			$4.625

Accordingly, on the foregoing basis a consumption of 75 kw.-hr. would average 6.16c. per kilowatt-hour.

Wright Demand Rate

The term "Wright demand rate" applies to that method of charge in which a maximum price per unit is charged for a certain amount of electric energy, and one or more reduced prices per unit are charged for the remainder, on the block principle, in accordance with a schedule based on the use of the maximum demand. This method of charge was developed by Arthur Wright and has come into extensive use for general lighting, commercial lighting, retail power and wholesale lighting and power. It is based on making a charge according to the number of hours' use of the maximum demand requirements. In other words, for the first hour's use per day, or aggregating 365 hours per year of maximum demand, the consumer pays a higher rate than for electric energy used in excess of the maximum. The Wright maximum-demand meter has become popular with central stations in connection with this now standard rate form. This method of rate computation in graphical form, plotted for a rate variation of from 9c. to 3c., is shown in Fig. 1. This curve is based on the following schedule:

For electric energy used equivalent to or less than the first 30 hours' use per month of maximum demand, 9c. per kw.-hr. For consumption equivalent to or less than the next 30 hours' use per month of maximum demand, 5c. per kw.-hr. And for all electric energy used per month in excess of the equivalent of 60 hours' use of the maximum demand, 3c. per kilowatt-hour.

As an example, assume that a consumer has a total connected load of 1000 watts, with a demand, estimated

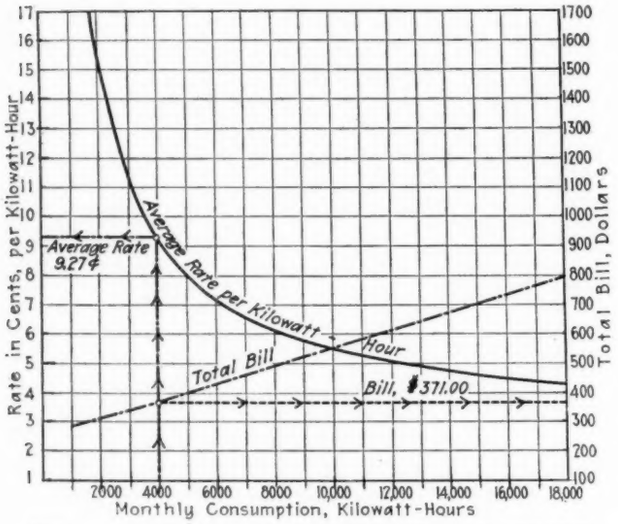


FIG. 1. GRAPHICAL REPRESENTATION OF WRIGHT DEMAND RATE

or measured, of 800 watts. On the basis of 30 hours' use of this demand (800 watts), the total is 800 × 30 = 24,000 watt-hours or, 24 kw.-hr.; this is the full amount to be charged for at the 9c.- and 5-c. maximum-demand rates. Say that the monthly consumption is 60 kw.-hr., the charge would be calculated as follows:

24	kw.-hr.	@ 9c. =	$2.16
24	kw.-hr.	@ 5c. =	1.20
12	kw.-hr.	@ 3c. =	0.36
60	kw.-hr.	Total...	$3.72

The average rate equals total cost in cents divided by total kilowatt-hours or, in this problem, equals 372 ÷ 60 = 6.2c. per kw.-hr. These values are indicated in Fig. 1 by the dotted lines. One of the prominent advantages of this method of rate calculation is found in the fact that it tends to encourage greater hours' use of the maximum demand, as the energy excess charges are low.

Hopkinson Demand Rate

The term "Hopkinson demand rate" applies to that method of charge which consists of a "demand charge," (a sum based on the demand either estimated or measured, or the connected load) plus an "energy charge" (a sum based on the amount of energy used). This comes under the term of a "two-charge rate." This rate, officially defined, is applicable to any method of charge for electric service in which the price per unit of metered electric energy for each bill period is based on both the actual or assumed quantity of electric energy consumed and the actual or assumed capacity or demand of the installation.

The Hopkinson rate takes its name from Dr. John Hopkinson, who presented its possibilities in 1892, after extensive central-station investigation and covering practically every phase of operation and expense. He held to the theory of the necessity for a fixed charge to be defrayed by the consumer, and according to his demand for power to cover the "readiness to serve" cost of production and distribution. The value of Dr. Hopkinson's work can be fully appreciated when it is stated that the majority of rate forms in use today are based, either in whole or in part, on his basis of assumption and computation.

In the Hopkinson demand rate the "demand charge" or the "energy charge," or both, may be of the block-rate type. The diagram, Fig. 2, sets forth this rate basis, taking 6, 4, 2 and 1c. per kilowatt-hour, for respective amounts of consumption.

Considering a practical example of the method of figuring rates under this system, assume a "demand charge" and an "energy charge" as follows:

Demand charge—$2.50 per month per kilowatt for the first 50 kw. of maximum demand in the month; $2 per month per kilowatt for the excess of maximum demand over 50 kilowatts..

Energy charge—6c. per kw.-hr. for the first 1000 kw.-hr. used per month; 4c. for the next 2000 kw.-hr.; 2c. for the next 2000 kw.-hr.; and 1c. per kilowatt-hour for excess over 5000 kw.-hr. used per month.

Now, assume that the consumer has a demand of 100 kw. and uses a total of 8000 kw.-hr. in a month, the bill would be calculated as follows:

50	kw.	× $2.50 =	$125
50	kw.	× 2.00 =	100
100		Total demand charge	$225
1000	kw.-hr.	× 6c. =	$ 60
2000	kw.-hr.	× 4c. =	80
2000	kw.-hr.	× 2c. =	40
3000	kw.-hr.	× 1c. =	30
8000	kw.-hr.	Total energy charge	210
		Total bill.....	$435

The average rate is 43,500 ÷ 8000 = 5.437c., and is indicated with the other items on the curves, Fig. 2, by dotted lines. As will be understood, the "demand charge" holds at the same figure from month to month, or as long as the maximum demand remains unchanged.

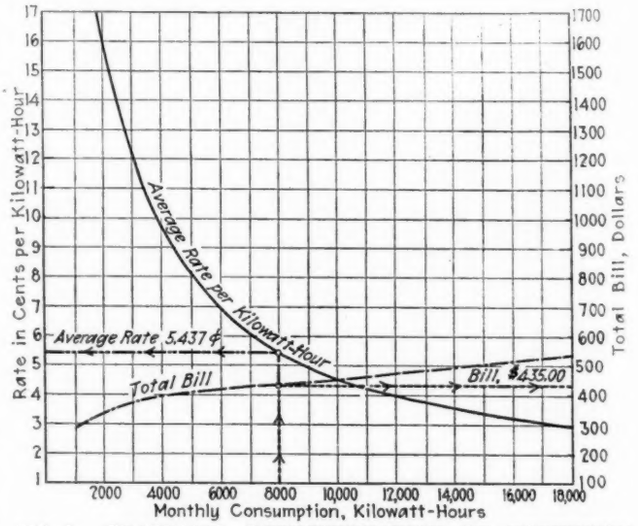


FIG. 2. GRAPHICAL REPRESENTATION OF HOPKINSON DEMAND RATE

The "energy charge" is the fluctuating element, varying from month to month in accordance with consumption.

The term "three-charge rate" is applicable to any method of charge for electric service in which the charge made to the consumer for each bill period consists of, (a) a sum based on the quantity of electric energy consumed, (b) a sum based on the actual or assumed capacity or demand of the installation, and (c) a charge per consumer.

Accordingly, a definition of the Doherty or "three-charge" rate would be: That method of charge which consists of a "customer charge," or a charge per customer per meter; plus a "demand charge," a sum based on the demand, either estimated or measured, or the connected load; plus an "energy charge," a sum based on the quantity of electric energy used. This rate may be expressed in either the "block" or the "step" form, terms that have been previously explained. As will be noted, this system adds a customer charge, or meter

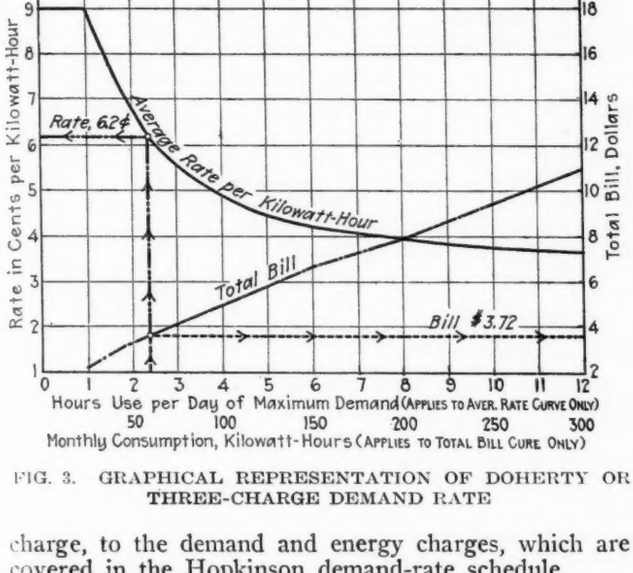

Rate in Cents per Kilowatt-Hour
Total Bill, Dollars
Rate, 6.2¢
Average Rate per Kilowatt-Hour
Total Bill
Bill $3.72
Hours Use per Day of Maximum Demand (Applies to Aver. Rate Curve Only)
Monthly Consumption, Kilowatt-Hours (Applies to Total Bill Cure Only)

FIG. 3. GRAPHICAL REPRESENTATION OF DOHERTY OR THREE-CHARGE DEMAND RATE

charge, to the demand and energy charges, which are covered in the Hopkinson demand-rate schedule.

The Doherty charge was developed by Henry L. Doherty, New York, and presented before the National Electric Light Association in 1900, and has become useful for certain phases of power service. The first two charges enforced, "customer charge" and "demand charge," are designed to cover the cost of "readiness to serve," while the third, or "energy charge," provides for the actual consumption. Again, in further explanation, the customer and demand charges cover the average cost of service connections to the central station.

The typical curves in the diagram, Fig. 3, show the basis of the Doherty rate, at 5c. and 3c. per kilowatt-hour for amounts of consumption as expressed in the following example; the curve covering the average rate per kilowatt-hour indicates effectively the decrease in charge as the consumption increases.

The method of figuring a bill under this rate is very similar to that used for the Hopkinson rate, previously described, simply adding another established charge to the form. Taking a typical example:

Customer Charge—$1 per month per meter.

Demand Charge—$2.75 per month per kilowatt for the first 40 kw. of maximum demand in the month; $2 per kw. for excess of maximum over 40 kilowatts.

Energy Charge—5c. per kw.-hr. for the first 1000 kw.-hr. used per month; 3c. per kw.-hr. for excess over 1000 kw.-hr. used per month.

On this rate basis assume that the consumer has a demand of 100 kw. and uses a total of 4000 kw.-hr. in a month, the bill would be computed as follows:

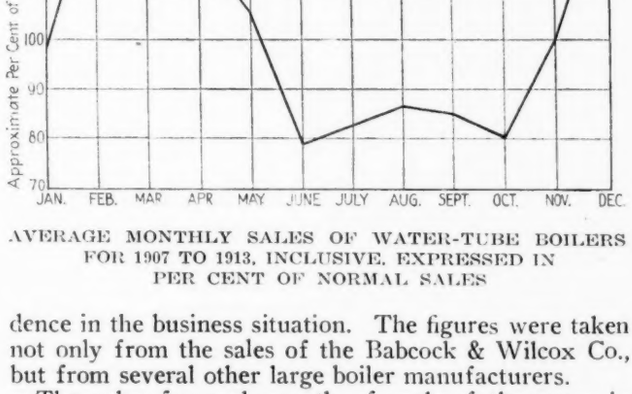
			$ 1.00	Customer charge
40 kw.	× $2.75 =	$110.00		
60 kw.	× 2.00 =	120.00		
100			230.00	Total demand charge
1000 kw.-hr.	× 5c. =	50.00		
3000 kw.-hr.	× 3c. =	90.00		
4000			140.00	Total energy charge
	Total bill.....		$371.00	

The first two charges noted are uniform from month to month unless a change is made in the installation and, consequently, in the maximum demand. The last charge varies from month to month as the total amount of electric energy fluctuates.

For additional explanation of the reason for the demand and energy charges brought out in the Hopkinson and Doherty rate schedules, it should be noted that these cover specific functions of central-station operation. The demand charge represents the return on the necessary investment to carry the maximum load that the consumer will have. It does not include any charge for the actual electric energy used. On the other hand, the energy charge is a charge proportional to the kilowatt-hours, horsepower-hours or lamp-hours, consumed; it does not contain any investment charge or overhead commercial charge, but such items as labor, fuel cost and supplies.

Season Fluctuations in Boiler Industry

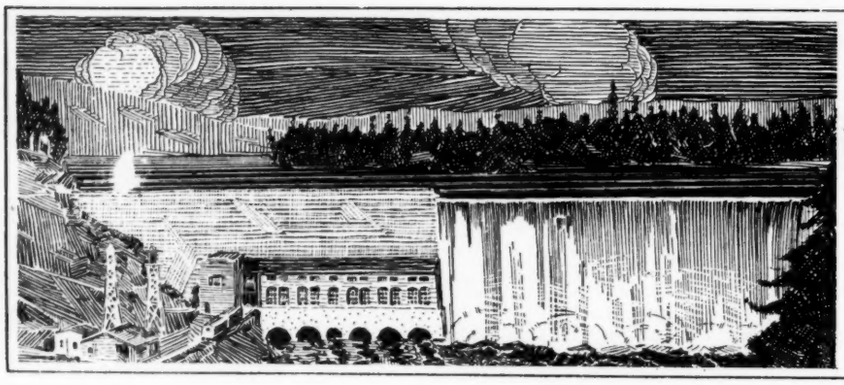
It may surprise many to know that there are seasonal fluctuations in the boiler business, but such appears to be the case from statistics compiled by A. G. Pratt, vice president, Babcock & Wilcox Co., and recently presented before the meeting of the American Boiler Manufacturers' Association in New York. The data, as shown by the accompanying chart, cover water-tube boilers for the years 1907 to 1913, inclusive, this covering a period of normal or nearly normal business activity throughout the country. Any figures for 1914-15-16 would show the effects of the war in Europe, and 1917-18 would, of course, be extremely abnormal, as boilers for war purposes were required in excess of the maximum production of the manufacturers. Sales during 1919 were not included, as that year was considered abnormal; in the first five months general business conditions were unsettled, and practically no buying of any character was done; during the last seven months business was extraordinarily good, due to returning confi-



AVERAGE MONTHLY SALES OF WATER-TUBE BOILERS FOR 1907 TO 1913, INCLUSIVE, EXPRESSED IN PER CENT OF NORMAL SALES

dence in the business situation. The figures were taken not only from the sales of the Babcock & Wilcox Co., but from several other large boiler manufacturers.

The sales for each month of each of the years in question were listed and divided by the number of years considered, which gave the average for each month. From this the ratios between the actual and the average monthly sales for the entire period were found and plotted. The figures plotted on the chart show, first, that the sales were equal to or above normal from February through July and again in December; second, that sales were below normal in January and from August through November; third, that sales in different periods vary from a maximum of 120 per cent to a minimum of 70 per cent normal.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"WELL," announced Pop as he walked into Jimmy's room and threw his hat on the bed and himself in the softest rocker, "we're fired!" The old chief let his lower jaw hang to give, as the advertising men say, "atmosphere" to his scene.

"Fired? What do you mean?" blurted Jimmy.

"Well, we're fired outa the ol' steam plant, an' tomorrer we goes up the creek an' we takes the new hydro plant in hand. They's also the mere trifle of a fivespot a week raise in it for you." Pop put his thumbs under his suspenders while he watched the effect on Jimmy.

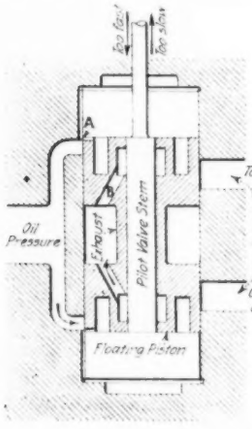


FIG. 1. PRINCIPLE OF MODERN PILOT VALVE

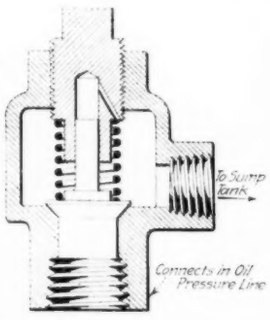


FIG. 2. VIEW OF BYPASS VALVE

"As yer might expect, I'm gonna be the boss an' you the feller wot does the work!"

"Which means, Popsie, that in about a year I'll be boss!"

Pop hurriedly changed the subject, as things were not taking the proper path.

"We'll git busy while th' gittin's good. We was a-talkin' the last time about pilot valves an' such like. I made a skitch of a pilot valve simplified so that you could git th' idee easy. Now, here (refer to Fig. 1) is a drawrin' that I made which shows the principle of the modern valve. Now git me when I says that this one ain't the only pebble on the beach, nor is it the only way or style that they can be made in. The fundymental idee of a pilot valve is that a dingus that must be delicate an' easily operated in order not to jim the sensitiveness of the governor flyballs, moves a little an' in so doin' calls into action a larger valve which has the necessary valve area to distribute the oil to the servomotor without excessive friction. There it is in a nutshell."

Jimmy fixed his gaze on Fig. 1, and a dozen possible cycles of operation passed through his mind.

"Now it works this way," resumed the old chief. "In the center of the drawrin' is located the exhaust port, which couldn't be shown very plain. On the left-hand side is the pressure-oil port. So, now, you sees that I has two litttle grooves cut in the body of the valve casing above and below the floating piston. Their purpose is to keep pressure oil always on both sides of the floatin' piston so that it is balanced an' therefore easily movable. The same ports or grooves helps keep the pilot-valve stem balanced although the balancin' idee ain't carried out in my design. To be right, the valve stem should be of the same size where it passes through the valve body at the top, an' the lower end ought go through the valve body, too. Then you has no end pressure on the valve stem an' the thing is balanced, seein' as how the side pressures neutralize themselves all around the valve stem.

"The floating piston has a few small grooves cut in the extreme faces in order to let the pressure oil git to the upper an' lower faces to carry out the balancin' idee, or otherwise the thing might settle down at the bottom of the valve body an' fergit they was a job to do. When the speed is normal, both valves assumes a central position as shown on the drawrin'. As soon as a change in speed occurs, let's say that some load has gone off the unit an' that the turbine is now runnin' too fast, then the pilot-valve stem will move downward, in the deerection of the arrow. When that happens, the hollow space at the top of the floating piston is uncovered an' the pressure oil that was in that space rushes through the small port *B* an' drains into the exhaust. This produces a severe case of what steam engineers calls wiredrawrin' at the little grooves marked *A* an' a unbalanced condition of pressure, the oil pressure bein' still workin' full on the bottom of the floating piston an' a hull lot less on the top. The result is that the floating piston is forced to the top of the valve body an' the trapped oil passes through the port *B* to the exhaust. In so movin' to the top of the valve body, the port marked 'to open gates' is connected with the exhaust, an' the other, marked 'closing side of servomotor,' is connected with the pressure oil port. The turbine gates is then moved an' the restoring mechanism returns the pilot valve stem to its proper place, which reverses the condition of affairs an' returns the floatin' piston to its normal place."

"I must admit that I understood that, only I guess that the actual work is done in about one-tenth of a second," said Jimmy.

"Yep, I reckon as how it don't take more then a dern small part of a second to do the hull thing."

"I suppose," commented Jimmy, "that those pilot valves have to be made just so to keep down leakage and that it takes very accurate work to produce a satisfactory valve. It seems to me that if the leakage was

much more on one side of the floating piston than on the other, it would tend to make the governor act without the flyballs getting in on the deal at all."

"Yep, that could happen. Pilot valves an' floatin' pistons is usually ground to the exact size, an' the clearance ain't usually more than two or three thousandths of an inch. In most governors, the pilot valves has the ports for the pressure oil an' the exhaust ports chipped to a jig so that they comes in the right place, 'cause foundry work might make the ports come too much either one way or t'other. The valve stem is usually made of steel which has about 3½ per cent of nickel which gives it great toughness, an' the floating piston an' valve body is often made of Govamint bronze, the same bein' 88 parts copper, 10 tin an' 2 zinc, which is a good mix an' lasts long under the throttlin' an' wire-drawrin' that must an' does occur in sich a valve."

"You said something about there being a gear pump to these governors. Is there any particular reason that the builders prefer them to piston or plunger type pumps?"

"Yep, they's quite a few reasons. One is that a gear pump is a small, compact thing that can be driven at high speed, an' when they is made good they has good mechanical an' tightness efficiencies. Another, which kinder follows from the first, is that they are easy to get into the small spaces that people thinks governor pumps should occupy an' that they can be made quite cheap, although don't git the idee that them gears, which is usually made o' 3½ per cent nickel steel an' has cut teeth, comes free."

"What gets me is how they can get those gears tight enough so that they won't leak half the oil that they pump."

"Oh, that's toler'ble easy. Them gears is turned about three or four thousandths less than what the gear case is bored, an' the side clearance is usually made two thonsandths on each side. When the clearances is less than what I told yer, they is a strong tendency for the pump to heat up. If the heatin' continues long, the oil is liable to break down an' lumps of carbon be deposited in the pipes, jes' the same as carbon will be deposited in fuel-oil headers if the oil gits too hot."

"But governor oil is refined, isn't it?" insisted Jimmy.

"True enough! That don't prevent it from boiling if it gits too hot, does it?"

"S'pose not. I suppose, though, like water, that the fact of the oil being under pressure raises its boilin' point and that the decomposition point must be somewhere near there."

"I don't know about that, son. All I knows is what I told yer, that the oil does break down after long use at high temperatures an' high pressures. The use, itself, at high pressures ain't so bad; but it's the high temperatures that kills it purty quick."

"That brings back a thing I wanted to have thrashed out—how do they know how large to make these servomotor cylinders?"

"It depends how you wants me to answer that question. If you wants to know just what force it takes to move them turbine gates at any point, I'm afraid that I can't answer it. The problem of the pressures on the front an' back sides of a gate is a deep one. Most builders uses an empirical formula which has enough leeway to it that they is safe. Their rule is about like this:

"Multiply the horsepower of the turbine by 40 if the turbine has inside gate mechanism an' divide the product by the square root of the head. This gives the foot-pounds of energy that the governor cylinder should have. If the governor handles a unit with outside gate mechanism, that meanin' one with the governor connections out of the water, use a constant of 50 instead of 40."

"The capacity of the governor in foot-pounds is the area of the cylinder in square inches times the oil pressure in pounds per square inch, times the stroke in feet, ain't it?"

"Certainly. You got it that time, Jimmy. They is a small loss due to friction, but it don't amount to much.

"Now I wants you to take a look at Fig. 2. This is a bypass valve. The idee is to lighten the work on the motor that drives the oil pump, or whatever source of power is used. When the pump has generated sufficient pressure to overcome the leakage in the different joints, if no bypass valve is used the pump pressure will build up an' increase, taking a lotta power for no good use. Just as soon as the right pressure exists in the pipe from the pump to the pilot valve, the bypass valve is opened an' the oil passes back into the sump tank, relievin' the pump of all the extra work that it would git from havin' the pressure build up on it. You see that the tension on the spring can be changed by screwin' up on the setscrew an' the pressure changed accordingly."

"Now tell me what that little port that is drilled through the setscrew is for."

"Nothin' more than a hole to let the trapped oil get through when the valve opens. They's always some little oil gits through the valve-stem clearance up into that space, an' that hole is jes' a drain."

"Now why couldn't the whole thing be done electrically? I mean the governing of the unit and all that sort of thing?" Jimmy was getting pretty deep into one of his inventive moods.

Pop leaned back in his chair and gazed steadily at something that was not where he gazed. "I heerd tell o' somethin' like that an' I'll tell yer about it. They once was an engineer feller who invented one o' them critters, an' I has the patent specifications down in my carpetbag some place. One of the engineers of a prominent turbine company said that to his best knowledge and belief the thing was divided into three parts. One part, the first, was quite simple to understand to the ordinary mechanical engineer with about ten or twelve degrees after his name an' who was born on the 31st of February. The second part, along with the first, was understandable to the inventor an' the Lord, but beyond any other human bein'. The last part the Lord has long since given up in despair, an' the inventor only had a shadowy idee of it himself. They never was any governor made after his specification, an' they most likely never will be."

"But, Popsie, can't it be done?" insisted Jimmy.

"It would seem that it can be done, son, but the time don't seem to be ripe now. It seems to me that it will be done that way some time in the future, and maybe it will be some solenoid-operated critter which will exert a pull or thrust proportional to the current flowing in the circuit. That might be connected to the gates in some way an' like a voltage regulator it may be the right trick."

The French Alpine regions of Dauphiny and Savoy have become the centers of electric-steel making; 1,045,000 hp. is supplied by the French Alps today, against 70,000 in 1890. This hydraulic power represents the equivalent of 6,270,000 tons of coal. Of this total, metallurgical operations absorb 303,000 hp., chemical operations 255,000, while the remainder is divided between other industries and light and traction service.—*Iron Trade Review.*

Dispatching Method of Operating Boiler Plant

When the quantity of steam required varies greatly from time to time, the rate of producing steam cannot be changed quickly enough in a plant with numerous large boilers to insure an adequate supply at highest boiler efficiency. Furthermore, steam required for any load curve can be produced by various combinations of boilers at different ratings, and the selection of the best combination is important.

To enable advantageous operation of boilers on a load which is subject to wide differences in daily requirements for energy, a plan has been developed for the Ashley Street plant of Union Electric Light and Power Company, of St. Louis, which is as follows:

The need was felt for a unit which was common to both prime movers and boilers and the name "kilber" was devised to stand for 1,000 lb. of steam per hour (450 kg. per hour). It is a combination of "kilo" (one thousand) and "lb." (pounds) with the euphonic abbreviation "er" representing "per hour." Since the adoption of this name the terms "kilowatts" and "boiler-horsepower-hours" are seldom heard in the boiler room. The steam-flow meters are now calibrated to read directly in "kilbers."

The system load dispatcher forecasts the load requirements and instructs the steam-plant operator what

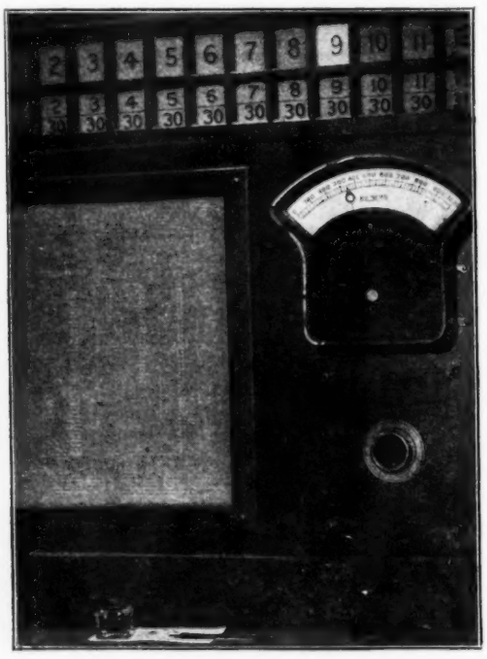


FIG. 1. BOILER-ROOM DISPATCHING BOARD AT OPERATOR'S CONTROL DESK

The number of "kilbers" shown on the "kilberscope" here and on the one in the boiler room is regulated by the handwheel under the instrument. The illuminated figure near the top of the board gives the time when the "kilbers" will be required. The framed tabulations to the left give the number of "kilbers" required for any load with different turbo-generator combinations.

load, in kilowatts, will be required from that plant one-half hour later. The quantity of steam in "kilbers" which will be needed for that load with different combinations of turbo-generators is shown by a glance at the chart at the left in Fig. 1. The operator then orders from the boiler room the proper number of "kilbers" for delivery at a designated future time.

The apparatus for signaling orders and acknowledgments between the switchboard gallery and the boiler room is simple and effective. A circuit, containing a rheostat, runs from the operator's control desk to the boiler room and connects two illuminated dial voltmeters graduated in "kilbers." These "kilberscopes," as they are called, are mounted near time indicators which have twenty-four separately illuminated compartments numbered to correspond with the hours and half-hours.

The operator's control desk, the rheostat wheel below the kilberscope and the time indicator above this instrument are shown in Fig. 1. When this photograph was taken 340 kilbers had been ordered for nine o'clock. Having set the "kilberscopes" at the desired reading, the operator closes a circuit which illuminates a compartment of the distant time indicator and actuates a claxon alarm in the boiler room. The alarm continues

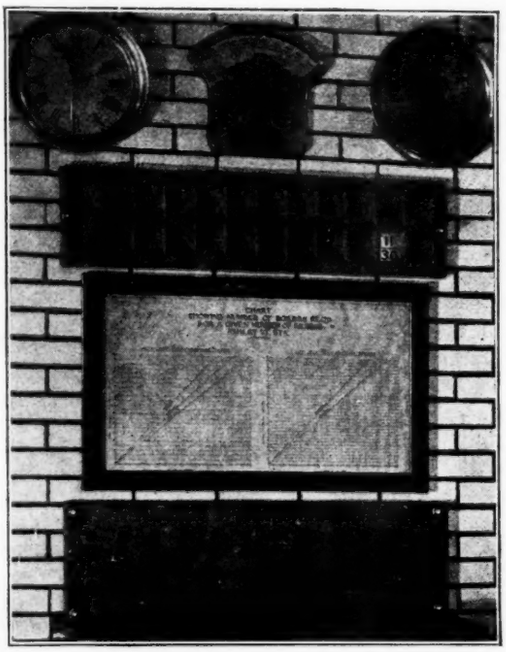


FIG. 2. SIGNALING BOARD IN BOILER ROOM

The "kilberscope" and time indicator are similar to those in Fig. 1. The chart here gives the output in "kilbers" from boilers in each of two groups when operated at different percentages of their rated capacity.

to sound until the boiler-room attendant closes a circuit which illuminates a corresponding compartment for the time indicator at the control desk, thus acknowledging the order. The apparatus shown in Fig. 2 is installed in the boiler room. The illustration shows that 265 kilbers will be required at 11:30. The chart shown in the illustration gives the "kilber" output of the boilers in each group when operating at different percentages of their rated capacity.

This system eliminates the use of an unnecessary number of boilers under bank or operating at reduced capacity. It reduces the probability of misunderstanding between boiler room and turbine operators, and is a convenient means of placing the load dispatcher in more effective control of results. The economies produced have been important and have stimulated the plant employees to greater efforts to add to their bonus earnings by effecting further economies with the use of this new tool.

A deposit of coal has been discovered at La Union in Chile. It contains 40,000,000 tons of good-quality fuel. Veins have also been struck at Mailef, near Valdivia, and in the Castro district, and these are being exploited.

The Uniflow Engine

THERE are certain large losses in the steam engine which cannot be overcome, but almost from the beginning two losses have been known which can at least be greatly reduced. These are the loss due to incomplete expansion of the steam in the cylinder and that occurring when the steam enters the cylinder which has been cooled below the temperature of the entering steam during the expansion and exhaust stroke. This loss is known as initial condensation.

The cooling of the cylinder is brought about largely by reëvaporation from the hot surfaces of moisture that

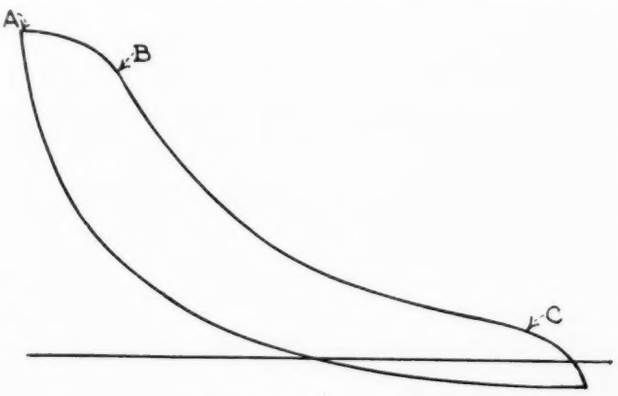


FIG. 1. UNAFLOW-ENGINE INDICATOR DIAGRAM

has been deposited upon them, and as most of this reevaporation takes place during the exhaust stroke, heat is directly transferred by it from the higher-temperature level to the condenser or atmosphere without doing useful work. The heat so abstracted must be restored by the incoming steam, which, if it is not superheated, can give up heat only at the expense of condensation.

A convincing demonstration of the cooling effect of evaporation may be had by standing before a hot-air register when you emerge from your bath. The current of air, which appeared so hot to your dry skin before, has now become a chilly draft. Its temperature is the same, but the rapid abstraction of heat from the body by the evaporation of the film of moisture upon it produces the sensation of cold. Artificial refrigeration is produced by the evaporation of ammonia and other volatile fluids. In tropical countries water is cooled in jars from the wetted felt covering of which moisture is evaporated by the heated atmosphere.

The loss due to incomplete expansion is reduced by cutting off the steam in the cylinder before the end of the stroke; the shorter the cutoff the less this loss, but the shorter the cutoff the greater the loss due to initial condensation. In the ordinary type of engine, on account of the greater cooling effect due to increased expansion, this latter loss equals the gain at about one-quarter cutoff, so that there is no economy in shortening the cutoff beyond this point.

Builders soon learned that by making two cylinders of different diameters and exhausting from the smaller into the larger, initial condensation was greatly reduced, as the difference between the initial and exhaust temperatures in each cylinder was cut in two, and as the total number of expansions is the product rather than the sum of the expansions in all the cylinders, the steam was exhausted at a low terminal pressure, so the loss due to incomplete expansion was also reduced—hence, the compound engine.

It might be reasoned that by putting a large number of cylinders in series, initial condensation could be reduced to that occurring in one of the cylinders, and this is theoretically true, but there is a loss in getting the steam from one cylinder into the next. The more cylinders in series the greater this loss, so that this would in time offset the gain by getting rid of initial condensation. This, combined with the extra cost, has precluded the use of more than four cylinders in series, and there were very few of these. In fact, excepting in marine and pumping engines, there are few compounds of more than two cylinders.

The compound engine was the only known way of getting high degrees of economy in a steam engine up to 1908, when Prof. Johannes Stumpf of Charlottenburg, conceived the "Una-Flow" engine with only the inlet end jacketed. This design practically eliminated initial condensation so that the steam might be cut off very short, permitting of a great deal of expansion in one cylinder, with consequent low terminal pressure. This reduced the incomplete expansion loss, saved the loss due to the transfer of steam from one cylinder to the other, and the greater radiation loss due to a multiplicity of cylinders inherent in the compound engine.

Professor Stumpf started with the idea of isolating so far as possible the parts of the engine heated by the incoming steam from the parts kept cool by the comparatively cool exhaust, and from the exhaust steam itself, in order that there might be a minimum of transfer of heat that did no work. Much of the superior economy of the four-valve over the single-valve engine is due to the use of a separate exhaust valve, instead of leading the incoming steam through a port and over surfaces that had just been bathed by the cool and moist exhaust. He adopted the idea which had been tried by Eaton in this country in 1857, and Todd in England in 1885, of taking the steam into the cylinder at the ends

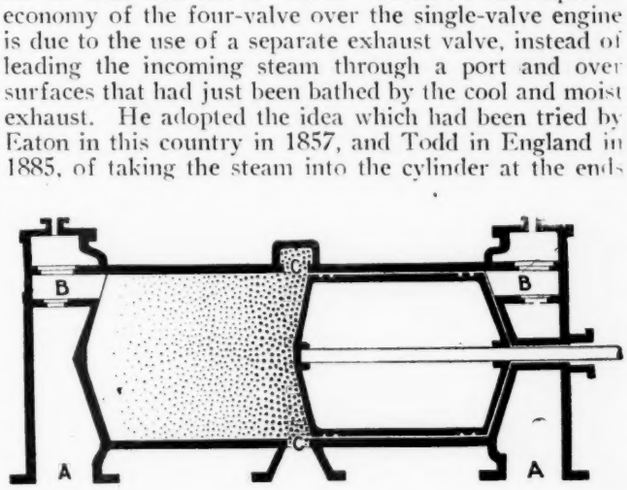


FIG. 2. SECTION THROUGH UNAFLOW-ENGINE CYLINDER

and exhausting it at the center, in order that there should be no back-flow of cold exhaust steam across the hot inlet end. It was this unidirectional flow which gave to this type of engine the name of Uniflow, or "Una-Flow," as the Stumpf people write it.

Neither Eaton nor Todd made a commercial success of his engine and it was evident that something was lacking. This missing link was supplied by Stumpf, who heated the inlet end of his engine by means of live-steam jackets.

The result of this heating was the forcing of the moisture caused by converting heat into work during expansion to the cold end of the cylinder, so that it would be wiped out of the cylinder when the piston uncovered the exhaust port. The most important effect of this is that the inlet end of the cylinder, being dry

when the drop in temperature takes place, does not give off its heat by evaporation and so does not have to be reheated later. It will part with its heat but slowly by radiation and convection to a surrounding atmosphere of dry steam, while it would be rapidly chilled by evaporation if surrounded by a moist content. A good illustration of this action is seen in every blacksmith shop, where a piece of hot iron, if sprinkled with water, cools immediately, while it would retain its heat in a dry atmosphere for a long time.

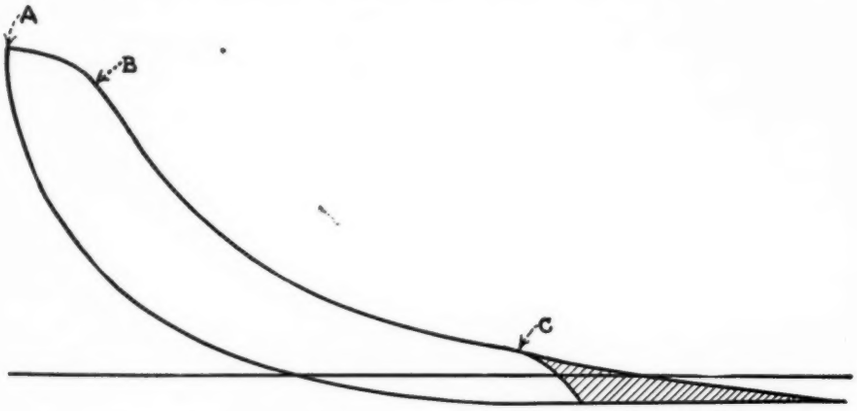


FIG. 3. UNAFLOW-ENGINE DIAGRAM AS IT WOULD APPEAR WITH CYLINDER LONG ENOUGH FOR COMPLETE EXPANSION

With the foregoing facts clearly in mind the Stumpf cycle can easily be followed. Referring to the indicator diagram, Fig. 1, steam enters at *A*, the valve remaining open until the piston reaches the point *B*, when it closes and cutoff occurs. From *B* to *C* the steam expands, dropping in pressure and acquiring moisture, due to the conversion of heat into work. The cylinder head being kept hot and dry by the steam jacket, the moisture is greatest nearest the piston, Fig. 2, so that when the piston uncovers the exhaust port at *C*, this moisture will be swept out by the flow of exhaust steam. At this time the inlet head, being dry, does not give off its heat, so that when the piston covers the exhaust port on its return stroke, there being no moisture nor cold cylinder head to absorb the heat of compression, and heat being added from the head jacket during compression, the temperature of the steam remaining in the clearance at the end of the compression stroke will be higher than the temperature of the boiler steam. When the piston moves away at the beginning of the next stroke, the high-pressure steam will enter a cylinder which is at a higher temperature than its own, hence there will be no initial condensation. Fig. 3 shows what the diagram in Fig. 1 would be like if the cylinder were long enough to carry the expansion down to the exhaust pressure. The shaded portion shows the loss due to incomplete expansion. Unfortunately, the diagram does not show the loss due to initial condensation, but from it can be computed the amount of steam that would be required to fill the cylinder up to the point of cutoff if there were no condensation; and if actual consumption is known, the difference is an approximate measure of condensation up to that point. This difference is rarely below 20 per cent.

Calculations From a Flue-Gas Analysis

By H. M. BRAYTON

In this article the author shows in a simple way how to calculate combustion losses easily.

THERE are two principal losses in the furnace: First, the loss due to incomplete combustion, and second, that due to excess air. The first of these was taken up by the writer in a previous article in *Power*. The reason for this loss was pointed out. In addition an analytic and a graphical method were given for actually determining this loss. It was pointed out that a small percentage of CO would cause a serious loss. It was explained that the formation of this harmful CO could be largely prevented by admitting sufficient air through the fuel bed and by keeping the brick walls well sealed, thus preventing cold air from seeping through and cooling the hot gases.

Every engineer knows that he must admit an excess of air through the fuel bed to get good results. This is, unfortunately, necessary, because much heat would be saved could we get results by adding just the theoretical quantity of air. The reason why we cannot do this is that the air does not go through the fuel bed evenly. Some parts will get too much air and others not enough. Holes will develop in the bed through which air will flow and practically never come in contact with hot carbon. Many designs of boilers aim to thoroughly mix the gases as they leave the fuel bed.

The greater the excess of air given the furnace the lower the efficiency will be. The excess air merely carries off heat from which there is no return. The engineer is continually called upon to balance the draft between these two sets of losses. If he does not add enough air, the CO will run high; if too much air, the loss due to the excess will be prohibitive.

The previous article gave the methods of determining the loss due to incomplete combustion. In this article the writer wishes to show in as simple a way as possible how the loss due to excess air may be determined. This procedure is not difficult, and little theory is involved. Every practical engineer should know how to do this. He will find that it comes in handy, and a knowledge of all these things tends toward the bigger pay envelope.

To carry out the calculations, we need a certain amount of data. As in the case of incomplete combustion we shall have to know the analysis of the flue gases. This should consist of the percentage by volume of CO_2, CO and O_2. The amount of nitrogen can be found by subtracting the sum of these substances from 100. There will always be some water vapor or steam in the flue gases as well as some of the inert gases, but the volume is too small to receive practical consideration.

In addition to the foregoing information we must know the ultimate analysis of the coal used. By ultimate analysis is meant the actual percentage of each of the elements, such as carbon, oxygen, hydrogen, etc., which the coal contains. In contrast to this we have what is

known as the proximate analysis, which gives the percentage of moisture, volatile matter, fixed carbon and ash which the coal contains. These values may be determined by a competent chemist, or for rough work, which would be good enough for practical purposes, they may be taken from a bulletin issued by the United States Geological Survey and which appears in many books for engineers. These tables also give the heat of combustion of the various coals, a value that is essential in all calculations pertaining to this work.

Several empirical formulas have been developed for the determination of the heat of combustion from the ultimate analysis of the coal. It will not be out of place to give them here because the engineer might have the analysis and not the heat of combustion. These formulas are not exact by any means, and yet they check well with experimental determinations. Dulong proposed the following:

$$\textit{Total heat} = 14{,}650\,C + 62{,}100\left(H - \frac{O}{8}\right) \quad (B.t.u.)$$

in which C is the per cent. of carbon, H the per cent. of hydrogen and O the per cent. of oxygen in the coal by weight.

Mahler has proposed the following formula:

$$\textit{Total heat} = 14{,}650\,C + 62{,}100\,H - 5400\,(O + N) \quad (B.t.u.)$$

in which N is the per cent. of nitrogen by weight and the other letters have the same significance as above.

Air Needed for Combustion

The moisture, carbon dioxide, argon, etc., in the air are too small in amount to be considered in a practical calculation. Neglecting these, air is made up of the following by weight: Oxygen, 23.2 per cent., and nitrogen, 76.8 per cent.; and by volume: Oxygen, 20.94 per cent., and nitrogen, 79.06 per cent. An easy way to remember the ratio between these two elements in the air is to think of air as a real compound (which it is not) and represented by the formula N_4O, which means four parts of nitrogen to one part of oxygen.

With this information it is easy to calculate the air required to burn a coal or fuel of known composition. To illustrate this point: When carbon burns to CO_2, it requires two parts of oxygen. The atomic weight of oxygen is 16 and that of carbon is 12. One pound of carbon will therefore require $32 \div 12 = 2.67$ lb. of oxygen. But air is 23.2 per cent. oxygen by weight, so that one pound of carbon requires $2.67 \div 0.232 =$ 11.5 lb. of air. This, of course, is for complete combustion to CO_2.

The same line of reasoning applies to the hydrogen content in the coal. The atomic weight of hydrogen is 1. One pound of hydrogen will require $16 \div 2 = 8$ lb. of oxygen, and $8 \div 0.232 = 34.5$ lb. of air. This hydrogen burns to H_2O, which is common water, and passes off in the form of superheated steam.

The foregoing may be stated in a single equation,

$$\textit{Lb. of air per lb. of fuel} = 11.5\,C + 34.5\left(H - \frac{O}{8}\right)$$

The calculation given does not consider the fact that most coals contain some oxygen. This action naturally reduces the amount of air needed for complete combustion. Most coals contain around 8 per cent. of oxygen. On this basis the air required per pound of coal will be reduced to about 10. The equation takes care of this in the last term.

Assume the analysis of a certain coal and go through the calculation on this basis. Suppose we have Pocahontas, a semibituminous coal with the following analysis: Carbon, 82.73 per cent.; hydrogen, 4.63 per cent.; nitrogen, 1.31 per cent.; oxygen, 4.42 per cent. The percentages of sulphur and ash are usually given, but are neglected here, as their effects are uncertain and small at the most.

From the atomic weights we determine that each pound of carbon will yield 3.67 lb. of CO_2 and each pound of hydrogen will yield 9 lb. of H_2O. We shall, therefore, have from the above analysis:

$3.67 \times 0.8273 = 3.04$ *lb. of* CO_2

$9 \times 0.0463 = 0.42$ *lb. of* H_2O*; that is, steam*

To get the air required for combustion with this coal we shall have to apply the equation given above thus:

$$\textit{Lb. of air per lb. of fuel} = 11.5\,C + 34.5\left(H - \frac{O}{8}\right)$$

$$\textit{Lb. of air per lb. of fuel} = 11.5 \times 0.83 + 34.5\left(0.046 - \frac{0.044}{8}\right) = 11.33$$

The air contains 76.8 per cent. of nitrogen by weight, so that the total weight of nitrogen in this case would be $0.768 \times 11.33 = 8.7$. The coal contains 0.013 lb. of nitrogen, so we have a total of $8.7 + 0.013 = 8.713$ lb. of nitrogen.

Specific Heat Defined

The specific heat of any substance is that amount of heat that must be added to one pound of it to raise its temperature one degree F. Any of the good handbooks will give a table showing the specific heats of all the common elements and substances. The value for CO_2 gas is 0.217, which means that this many B.t.u. must be added to one pound of CO_2 gas to increase its temperature 1 deg. F. Similarly, the specific heat of steam (H_2O) is 0.481, nitrogen 0.244, and air 0.238. If any CO is present its specific heat may be taken at 0.245.

Fifty Per Cent. Excess Air

Suppose we assume that the flue gases show 50 per cent. excess air. Then calculate on this assumption. With this much excess air it is doubtful if there would be any CO. If the analyis showed any CO, then we would merely have to figure its weight and multiply this value by the specific heat of CO.

Heat Carried Off by Flue Gases

The following calculation is for the several components:

			B.t.u.
Carbon dioxide (CO_2)	3.04	× 0.217	= 0.660
Steam (H_2O)	0.42	× 0.481	= 0.202
Nitrogen	8.713	× 0.244	= 2.130
Air for dilution 50 per cent	6.09	× 0.238	= 1.450
Total			4.442

The figures given consider that there is no CO in the flue gas. There should be none with this amount of excess air. If there is any, it shows poor firing. If CO is present, simply treat it the same way and add it into the total.

Now suppose the temperature of the external air is 50 deg. F. and that you have ascertained the temperature of the flue gases at the base of the stack to be 550 deg. F. The difference is, of course, 500 deg., and the heat in the chimney gases above the temperature of the air becomes $500 \times 4.442 = 2221$ B.t.u. The value 4.442 represents the amount of heat necessary to raise one pound of the flue gas 1 deg. F.

Dulong's formula gives the heat of combustion in B.t.u. of this coal to be:

$$\text{Total heat} = 14{,}650\,C + 62{,}100\left(H - \frac{O}{8}\right)$$

$$\text{Total heat} = 14{,}650 \times 0.8273 + 62{,}100\left(0.0463 - \frac{0.0442}{8}\right)$$

Total heat = 12,150 + 2330 = 14,480 B.t.u.per pound, which checks closely with the actual calorimeter test.

It is customary to assume in this work that 10 per cent. of the heat of coal is lost in radiation through the walls of the furnace. The 2221 B.t.u. which are allowed to pass up the chimney are also a loss, making the total loss of heat 2221 + 1448 = 3669 B.t.u. There will then, remain to be transmitted to the water in the boiler 14,480 — 3669 = 10,811 B.t.u. The efficiency of the furnace with the 50 per cent. excess of air would then be 10,811 ÷ 14,480 = 75 per cent.

One Hundred Per Cent. Excess Air

Suppose now we have 100 per cent. excess of air. The amount of CO_2, steam and nitrogen would remain the same. The air for dilution would be increased from 6.09 to 12.18, and the heat carried off into the chimney gases by this constituent would be doubled. The total heat carried off would then be 500 × (4.442 + 1.450) = 2946 B.t.u. per lb. of coal.

The heat of combustion of the coal, 14,480 B.t.u., and the 10 per cent. loss by radiation remain the same. The amount of heat available for the water then becomes

14,480 — (2946 + 1448) = 10,086 B.t.u. per lb. of coal. The efficiency of the furnace becomes 10,086 ÷ 14,480 = 70 per cent., which is a loss of 5 per cent. due to this excess of air.

It is highly necessary that the engineer keep the excess of air low. The right way to handle this problem is to balance the loss due to excess air against the loss due to CO. The two are directly opposed. If the excess of air is cut too low, CO will appear. The engineer should take the analysis of the flue gases and run through the foregoing calculation. If the loss seems high, cut down the excess air until CO makes its appearance. Then determine the loss due to this CO as outlined in a previous article. Try to find a point where this loss is a minimum.

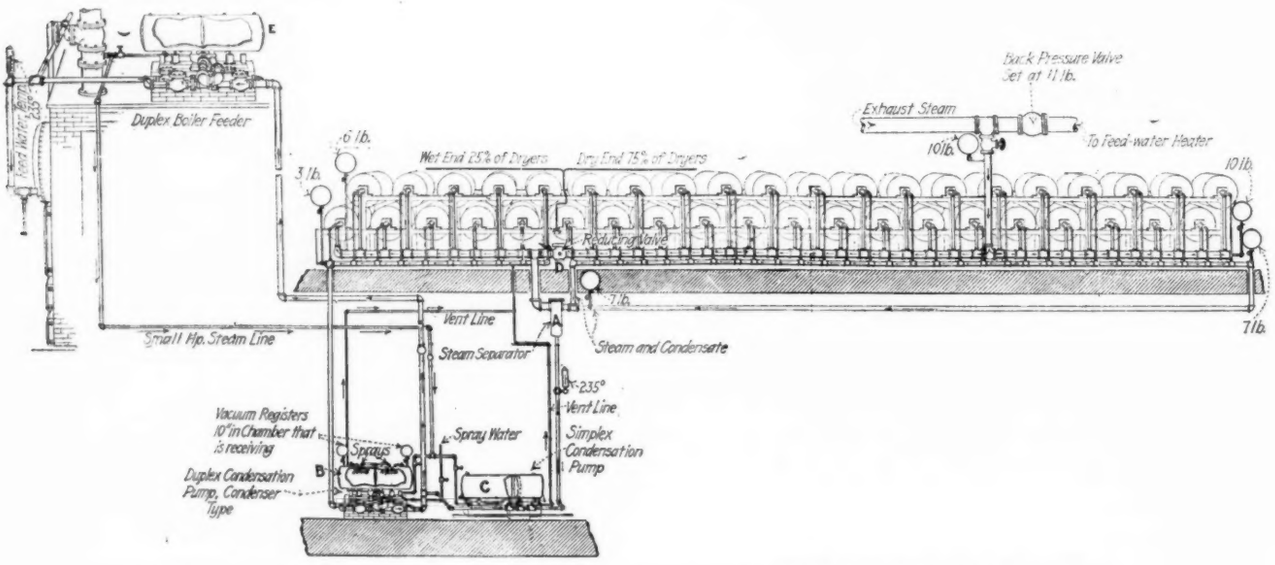
The problems outlined in this and a previous article are vital ones in any power plant. The up-to-date engineer will know how to handle them. If he does not learn, the other fellow will, and he will soon find himself in a minor position. Keep the furnace efficiency high, as the whole manufacturing world now has its eye on the power plant.

Boiler-Feeding System for Paper Mills

Paper manufacturers have experienced considerable difficulty in removing water and air from their driers, which prevents the circulation of steam through the driers and causes uneven drying. To eliminate this trouble a new system has been developed by the Farnsworth Co., Conshohocken, Penn.

A high steam velocity through the driers is effected by a forced steam circulation system which eliminates all water and air and provides a constant, even temperature through the driers. By means of a closed loop boiler-feeding system the condensation from the paper machine and all other heating apparatus, and makeup water as well, is held under pressure and returned directly into the boilers at a high temperature.

The paper machine is divided into two sections, one of these sections to have 75 per cent of the driers and the other the remaining 25 per cent. The steam and return headers between the two sections are cut, and a steam separator *A* is placed on the end of the return header for the dry end section which separates the condensation from the steam which has blown out into this portion of the return header. This steam is passed over



SHOWING ARRANGEMENT OF PIPING TO PAPER-MILL DRIERS AND BOILER FEEDERS

to supply the steam header for the remaining driers on the wet end. On the end of the return header for the wet end driers is placed at *B* a duplex condensation pump, condenser vacuum type. It has cold-water sprays in the top of the tank for condensing the vapors in the return line, producing a forced-steam circulation.

If insufficient steam should pass through the steam separator to maintain the required pressure in the wet-end section, steam is bypassed through a reducing valve *D* and the proper amount is supplied.

The condensation which is collected in the simplex condensation pump *C* and in the duplex condensation pump *B*, is pumped automatically to the receiving chamber of the duplex boiler feeder *E*.

The condensation from all high-pressure traps is discharged directly into the line leading to the receiving chamber of the boiler feeder *E*. The condensation from all low-pressure heating systems, fan coils, etc., is drained into the pumps *B* or *C* and is forced up to the receiving chamber of the boiler feeder *E* by the application of live steam on the surface of the condensate in the tank while it is in the receiving position.

EDITORIALS

On a Paying Basis

IT will be generally conceded that many power plants are operated less efficiently than might be expected. As to the causes, the one fault that really covers all the others is careless operation, and more often than otherwise this originates with the owner or management. Too often the management does not realize the importance of the service rendered by the power plant and has not grasped the idea that it is not merely a necessary evil that must be endured, but is in a sense a manufactory taking coal and water as raw material and turning out a finished product or service that is necessary to the establishment served by the plant and must be purchased elsewhere, usually at a higher cost, if not made on the premises. Think what would happen if the power plant in a hotel failed to function. There would be no lights, no heat, no elevator service, no hot or cold water, and every department in the hotel would be paralyzed. Purchasing the service from an outside source does not help matters, for it only shifts the responsibility to others over whom there is no control.

As the plant manufactures various products, it should be considered as a revenue-producing department worthy of more attention than it usually receives, and should be run on the same general principles as other departments. The same attention to checking up results should be given to power-plant performances as to restaurant operation. It is perhaps more difficult to check results in the plants than in the kitchen or storeroom, for measurements must be made of intangible substances by the use of suitable instruments. Some of these are simple and inexpensive, while others are complex and cost considerable money. These instruments should be considered as observers more accurate than a human could be, and their wage is the interest and depreciation on the amount they cost. Looked at in this way, they are not really expensive compared with the wages of a man, who at best could only guess at what was going on. The wage of this man should pay the interest cost on several thousand dollars' worth of recording instruments.

Use of these instruments and the readings they give will show whether the plant equipment is operated, or is capable of being operated, at a fair efficiency; or the indications may be that different apparatus should be used or that different methods of operation should be adopted. Without a reliable meter there is no way of knowing how much steam is being generated, and if the coal is not weighed as it is fired, the evaporation of water per unit of coal cannot be checked. Analysis of the flue gases and their temperatures reveals the reasons for the high efficiency obtained or the lack of it. Temperature readings and water measurements show the amount of refrigeration done. Indicator diagrams show plainly whether steam engines and pumps are wasting steam. Electrical instruments are required to check up the current output and energy consumption of the various devices operated by electricity. Given the necessary means of determining the points mentioned, equipment adapted to the work and a demand from the management for the reports of operation, a credible efficiency must result.

It has been said that one of the requirements for economical operation is machinery adapted to the work. Add to this a place adapted to the machinery. Too often the architect and others allow inadequate space, and it becomes necessary to install apparatus that is adapted to the space rather than the service. The logical method is first to determine the service requirements, then select equipment best suited to the work and provide a proper space for it. Any mistake made in this respect is hard to remedy.

In one of the largest buildings in Chicago plans were completed and the building well under way before it was discovered that no space had been allowed for boilers. Space was found and the boilers were installed in such a location that the plant is permanently handicapped and the mistake is evident every time a coal bill is presented. It is important to arrange the equipment so that it may be cared for easily, because then it will be best cared for. This is important, for unless constant attention is given and repairs promptly made, a well-designed plant will degenerate and give poor results.

Summarizing the requirements, it is essential to give the engineer the proper equipment to work with, locate it in suitable space, and check up his records. The plant will then show a percentage of profit that will compare favorably with any other branch of the business.

Co-operation Between Educational Institution and Industry

REFERENCE was made in a recent issue of *Power* to the new plan, devised by the Massachusetts Institute of Technology, for coöperation with the industries. As further details of the plan are made public, its importance, not only to the Institute but to all other technical schools and to the manufacturers of the country, becomes more and more obvious.

One of the big handicaps of the engineering schools has been the difficulty of maintaining close contact between the instructing staff and the industrial world. Industry's problems have reached the schools slowly and often only after they had ceased to be problems. On the other hand, research work inside the colleges was often devoted to problems which, while of value, were far from helping the immediate needs of industry. This same lack of intimacy was, of course, reflected in the type of education provided and was responsible for many of the, often unjust, criticisms of the technical man.

Another great difficulty confronting the colleges is the financial problem. Much has been said of the difficulty of keeping the best men on the college faculties at the salaries the institutions could afford to pay. It was the serious financial situation at the Institute which led to the proposal of the "Technology Plan."

This plan provides for a contract signed by a manufacturing concern and the Institute. A definite sum, annually, for a certain number of years is agreed upon, for which the Institute agrees to place its staff, equipment and libraries at the disposal of the manufacturer for advice and aid in the solution of his technical problems. A new division of industrial service has been formed and placed under the direction of Prof. William

H. Walker, head of the Research Laboratory of Applied Chemistry.

The success of the plan seems assured. Already over one hundred and fifty contracts, aggregating more than a million dollars, have been signed. The list includes many of the leading manufacturing concerns in the country.

On the side of the Institute the selection of Doctor Walker as director of this part of the work assures a capable administration. He is probably best known to the public as the man who, as a colonel during the war, successfully commanded the Edgewood Arsenal and developed it into the largest poison-gas plant in existence.

Can this idea, brought forward to meet a crisis in a single institution, be broadened to apply to others? Undoubtedly it can.

The larger manufacturers have long since recognized the need for research and have met it with their expensive laboratories and high-salaried investigators. The smaller manufacturer sees the need, but cannot afford extensive investigations. Under this new plan he will be able to turn to the technical school and will have access to men, apparatus and records he could never hope to make wholly his own, but which can serve him as fully as the need requires. On the other hand, the large corporation will probably retain its private laboratory, but will supplement it by that of the university.

This plan, in addition to assuring the technical school of an adequate income, also affords it an excellent means of keeping in touch with the outside world and bridging the gulf between education and industry.

The Year 1919 Encouraging Regarding Power Costs

WITH coal, labor and other materials, except capital, that enter into the production of power soaring to undreamed of prices, it is believed by many that the cost of power must increase considerably above prewar rates. Already increases have been granted in some cases to help meet the higher operating expenses of central stations. Just what the future holds in regard to the rate per kilowatt-hour cannot be predicted at this time. However, the results of the last year hold forth some encouragement. An investigation made by the *Electrical World* (the findings of which were published in its January thirty-first issue) to obtain an accurate idea of the distribution of the gross income of central stations between manufacturing and distribution expenses and income available to pay interest and dividends, shows that after a gradual decrease in net income for nearly ten years, reaching its lowest in 1918, in the last year the net income per unit has increased twelve per cent. Increased output, higher rates and a more efficient use of coal have no doubt had a big influence in this increase. Although the total effect of increasing the wages of central-station company employees is not reflected in this figure, the outlook is nevertheless encouraging, and gives promise that the cost of power may still be maintained somewhere near prewar figures.

In this investigation steam plants were divided into two classes—those of twenty-five hundred kilowatts capacity and over, and those under twenty-five hundred kilowatts. Where, in 1919, thirty-five per cent of the gross income of stations of twenty-five hundred kilowatts and over was available for paying dividends and interest on indebtedness, the net income decreased to only thirteen per cent in stations of less capacity. Apparently, this is a strong argument against the small independent central station, and undoubtedly it favors the concentration of central-station power generation in large efficient units. This, however, should not be confused with the independent industrial plant, since the former, besides the cost of producing power at the switchboard, has the additional cost of doing business, which the latter does not have.

Keeping Out of the Rut

THE letter "Keeping Out of the Rut," by Thomas M. Gray, published in this issue, is worthy of serious consideration by every *Power* reader. What Mr. Gray has encountered has been the experience of many others; they have found themselves growing stale on the routine work of their jobs. This is one of the most critical periods of an engineer's career; his future depends very largely upon the way in which he meets this condition.

If he takes the course chosen by Mr. Gray and searches out the cause of his negligence in his work and then applies some remedy, his success is assured. On the other hand, if he allows himself to drift along with the current, he will soon find that his services around a power plant are not required.

In every power plant a considerable part of the work must of necessity be routine; nevertheless, in every plant, whatever the job may be, there is room for initiative and resourcefulness to a degree that will give opportunity to exercise the skill and ingenuity of anyone who will take full advantage of his work. In keeping power-plant records, it is one thing to record the readings of the various instruments and events about the plant and a far different thing to correctly analyze and interpret them; and unless those who are entrusted with the keeping of these records are capable of analyzing them, they are surely not making the best of their position.

In the industrial power plant there are so many conditions affecting economic operations that the engineer who is looking for an opportunity to develop his engineering talent can always find it. Not only does such study make the work more interesting, but also, as Mr. Gray discovered, it leads to talking the language of the chief and opens the road to advancement. Mr. Gray has apparently struck a keynote that should appeal to every operating engineer. No doubt the experiences of many other engineers, of how they have made their work more more interesting, would be instructive to others, and *Power* correspondence columns are open for a discussion of the subject.

Give the youngster a chance. Besides running errands, helping with the ashes and grooming the engine and boiler, let him go through all the motions of starting and stopping your engine. He may not do everything exactly right the first time, but don't forget that if he had your experience he would be holding your job, or perhaps a better one. There are numerous instances where men have grown up in power plants and for want of a little encouragement always remained too timid to ask for instruction. Looking back on your early experience, you must remember your own shortcomings, your ambitions and the reasons for your advancement. Undoubtedly, you cherish and respect, more than all else, the tips received from your superior. It will be pleasant to contemplate that at some future time you may look back with the satisfaction that you did as you would be done by.

CORRESPONDENCE

Why Does Water Lift When the Safety Valve Blows?

The lifting of water in a boiler when a safety valve blows is due to the expansive force of the steam that is released from the body of water in the boiler when the pressure is reduced by the opening of the safety valve. The dry steam in the steam space rushes to the valve opening ahead of the pent up steam bubble in the water, otherwise water would come out with the steam whenever the safety valve lifted.

When a boiler is operating under normal condition, there are several elements working harmoniously, but when the valve lifts there is a sudden interference and the water is driven into the current of steam flowing through the safety valve. The steam bubble pent up within the body of water can be compared to tiny compressed coiled springs submerged in a body of water, which, when released, would throw the water upward.

Water contained in a steam boiler has a tremendous force stored up ready to act when the right condition prevails, which is brought about when the safety valve suddenly releases the pressure. The operation of a coffee percolator gives a good illustration of the action of heat within a body of water. The expansive force of steam generated in the water space forces the water to the top of the small tube when the steam expands and throws water to the top of the percolator.

The remedy for lifting water is to provide as large a liberating surface and steam space as is practical. The place to separate water from the steam is in the boiler if it is possible. Among the devices employed are perforated or slotted pipes, and baffle plates, the latter being the most satisfactory and effective device. It prevents the straight lifting of the water under the steam opening and also catches the water that may creep up the sides of the shell. It is easily attached to the boiler, is readily inspected and kept in proper condition, and is not expensive to attach.

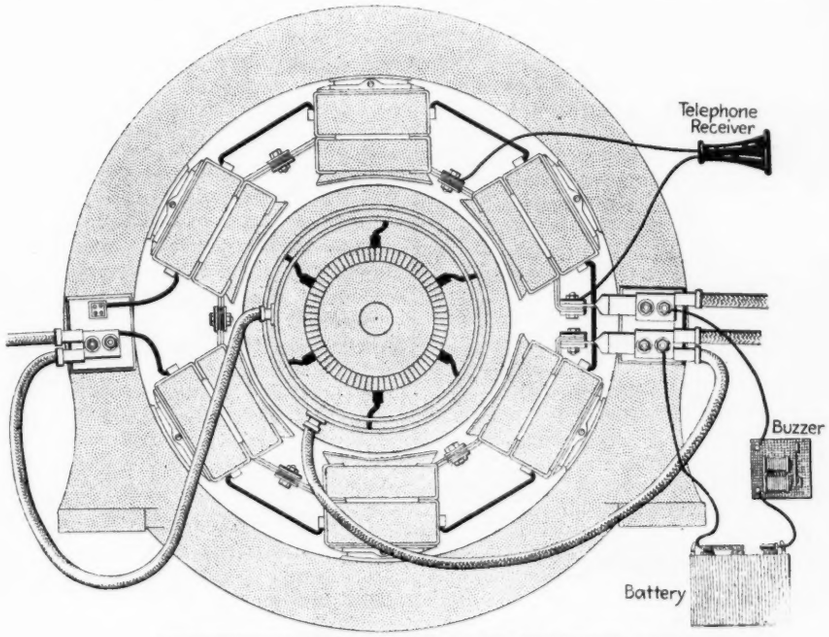
An important factor concerning this question is the size of the safety valve and the lift. If a boiler requires a large safety valve in order to relieve it of all the excess steam it is capable of making, two or more valves of small size should be used. Experience shows that a 4-in. valve is not too large.

Sioux City, Iowa. J. M. SHEA.

Locating Defective Field Coils

There are several ways of using a telephone receiver instead of a millivoltmeter to detect and locate faults other than those in an armature. As an example, some time ago, in an isolated plant operating a mine, a 150-kw. 550-volt, six-pole direct-current generator failed to maintain its voltage on full load. The speed, shunt excitation, etc., were the same as before the trouble. It was decided the difficulty was in the compound winding or probably part of a shunt-field short-circuited.

A set of batteries and a buzzer were taken from a Ford car, and a telephone receiver was taken off a near-by telephone. The buzzer and batteries were connected in series with the compound winding, and each series coil was bridged with the receiver, as in the figure. One failed to make the receiver vibrate, indicating that the coil was short-circuited. The shunt-field coils were also tested in the same manner, and it was found that a defective shunt coil had short-circuited part of the series coil that was on the same polepiece.



CONNECTIONS FOR TESTING SERIES-FIELD COILS

W. A. DARTER.
Brenham, Tex.

Scale Formed in Safety Valve

In the Sept. 16, 1919, issue, page 477, Thomas M. Gray relates his experience with scale forming in safety valves. This letter called to my mind trouble experienced along similar lines from the safety valves scaling on a high-pressure economizer installation.

In this case the water was forced through the economizer under a pressure of 160 lb. and from the economizer was fed to the boilers. No pressure regulators were used on the pumps feeding the economizer, and the feed-water regulation to the boilers was done by hand, the firemen looking after the water on their boilers. The ten boilers were of the vertical water-tube type, each of 300-hp. capacity. The load was variable and at times the plant was run at 225 per cent. rating. The stokers, forced-draft underfeed type, could maintain this rating continuously for a number of hours, and as the peak loads were frequent, dropping to less than 100 per cent. rating, water regulation by hand was far from satisfactory.

With poor regulation of the pumps and water to the boilers, the pressure on the economizer varied frequently, hence the entire feed-water lines depended for safety on the proper functioning of the four economizer safety valves, each 3-in. diameter connections, and the valves for a long time performed this work well.

The valves were placed on the discharge headers of the economizer and a 3-in. common drain header was run from the 3-in. discharge openings of each valve and a ½-in. drain line was run from the ½-in. drip of valve as shown by Fig. 1 into a 3-in. header at the tee. The waste water was run into the blowoff drain leading to the sewer.

The water used at this plant was drawn from a river seldom clear of mud. Even at its best it contained much incrusting materials, and as the economizer was really the first stage of heating the water and settling before it reached the boilers, it was not surprising that after six months' service one section of tubes and headers

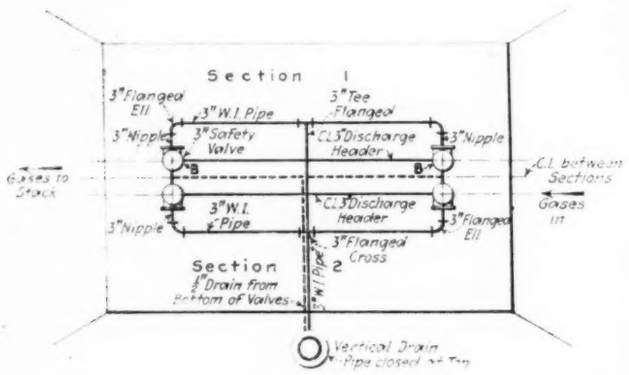


FIG. 1. ORIGINAL PIPING OF WATER CONNECTIONS

gave way, owing to a failure of the safety valve to release the excess pressure on that section of the economizer.

When the accident occurred, this economizer was cut out of service and inspected. It was found that hard scale had built up considerably in all tubes and that the two safety valves on this section (*A* and *B*, respectively) had become practically solid with scale around the seats and springs, and the discharge pipe was at least two-thirds full of scale.

After cleaning the section, making repairs to the headers and overhauling the safety valves, the section was filled and cut into service. Section 2 was then overhauled.

In order to remedy the trouble as far as the safety valves were concerned, I had the drain and discharge piping changed, as shown in Fig. 2, and run in such a manner that inspection could be readily made every day. Furthermore, a system of regularly cleaning the economizer was followed and safety valves were removed for cleaning and internal inspection not less than once in three months, as it was practically demonstrated that the safe limit of operation had been reached in that

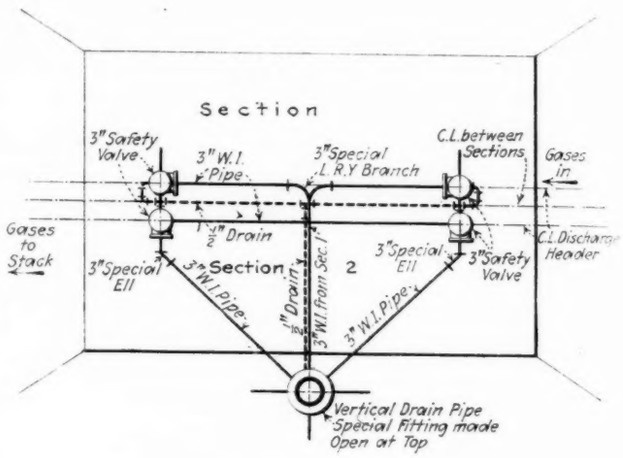


FIG. 2. NEW PIPING OF DRAIN PIPES

time under the existing operating condition. A further improvement was made by placing regulators on the feed pumps, so that excess pressure and undue lifting of the safety valves were stopped. After applying regulators to the pumps, the safety valves were lifted daily by hand to insure operation and to see that they were tight.

In this plant the twin safety valves on all boilers were allowed to blow through straight pipes run out through the side of the boiler house instead of running the safety valve discharge in a vertical line through the roof. This precaution was taken to prevent similar trouble, as explained by Mr. Gray.

PAUL R. DUFFEY.

Hagerstown, Md.

Keeping Out of the Rut

Readers of *Power* have lately exhibited an interest in meter readings. Several good examples have been offered for solution. Would the following comments be of any interest on the subject?

Given a specific problem in meter reading, no matter how complicated, and in the majority of cases the answer will be made correctly by the experienced meter reader. That, however, is no test of the ability of the individual. The real test comes when one has to read meters daily. It would be surprising to note the number of mistakes that will crop up. One may ask why? There are two reasons: First, the human element, and secondly, the carelessness that is due to routine nature of the work.

Mistakes are bound to happen in a power plant. However conscientious one may be in doing his work, sooner or later something goes wrong. This cannot be regarded as intentional; it is simply the human equation and in the majority of cases cannot be avoided. Carelessness may be due to lack of interest or to the fact that the work has become routine. Lack of interest in the work is inexcusable and ought not to be allowed under any

circumstance. The person is at fault and the remedy is self-evident. Now take the case where the work becomes routine. The monotony of reading meters day in and day out has driven more than one good man out of the business. There has to be an incentive, and no one can supply it except the man himself. Something new has to be injected into his work. The following tells my own experience, which may be of interest:

One of my duties when working in a central station was to get the midnight readings of the different meters in the plant. There were not many instruments, but after awhile errors cropped up and the matter would be called to my attention by the chief. For a while things would go smoothly, and then again errors would occur. That duty was getting to be routine. No matter how hard I tried, there were times when the meters would get barely a glance and the reading would be jotted on the daily log. It made things look bad for me, and it was not pleasing to the powers above. Who can blame them?

When it becomes necessary for the chief to check up the work of one his subordinates, the latter is going to fall very shortly. I faced that dilemma and planned how to remedy the fault. There was one way, namely, to keep one's own records in order that daily readings could be checked up. From simply checking up daily readings it was a slight step until these records included water rate, coal and other cost data. In a short time I had a new incentive. These records showed another side of the operation of the plant, which proved interesting and instructive. I was brought closer in touch with the chief, as I could talk the same language. The records were kept for a number of years, and although this meant a lot of extra work, I consider that it was worth while.

THOMAS M. GRAY.

Bayonne, N. J.

Remedy for Present Valve Setting

The indicator cards submitted by S. L. Gilliam, in the Sept. 23 issue of *Power,* from an 18 x 30 double-eccentric engine, seem to show that the head end is taking steam too early. It is hard work to prescribe for an engine from a distance, but from the information at hand I would proceed as follows:

First, make sure that the eccentric rod and reach rod are properly adjusted to give equal wristplate travel on

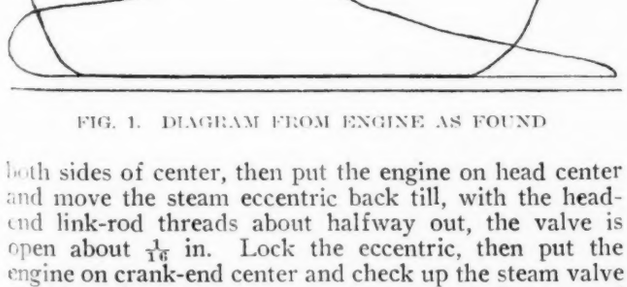


FIG. 1. DIAGRAM FROM ENGINE AS FOUND

both sides of center, then put the engine on head center and move the steam eccentric back till, with the head-end link-rod threads about halfway out, the valve is open about $\frac{1}{16}$ in. Lock the eccentric, then put the engine on crank-end center and check up the steam valve on this end, giving it the same lead. An indicator card should now show whether the load is equal on both ends of the cylinder, also whether admission is sufficiently early.

If the card shows improvement but still does not suit, change the adjustment slightly to give the desired effect. The fact that new valves have been fitted may be the cause of the trouble, so make sure that the marks on the ends of the valves correspond with the valve edges, also that the edges of the ports line up with the marks on the ends of the valve chambers.

I would not disturb the exhaust-valve setting unless necessary for quiet running, although the head-end ex-

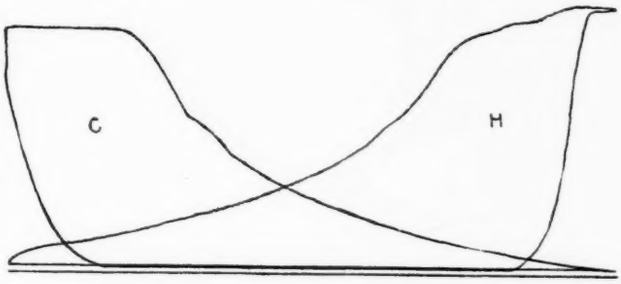


FIG. 2. DIAGRAM FROM ENGINE AS CHANGED

haust valve would stand a trifle earlier opening.

Syracuse, N. Y. A. H. BULLARD.

[The cards referred to in this letter are reproduced herewith as Fig. 1 and Fig. 2.—Editor.]

In any double-eccentric gear the exhaust valves operate the same as with a single-eccentric, with the exception that better results can be obtained by using the best setting for any particular case regarding release and compression percentages. The exhaust lines on Mr. Gilliam's diagrams are not entirely correct or equalized, but the valve setting, although deranged, is not enough so to cause serious trouble. The steam valves and the steam eccentric need adjustment, and there seems to be excessive leakage on the steam valves.

Double-eccentric steam gears differ considerably from single-eccentric gears. With the wristplate on the center the valves are open, but to what extent depends on the design of the valves, the valve travel and the range of cutoff to be obtained. The most important question is how much seal, or lap, the valves have when they are on the extreme closed position. In multiported valves for high-speed Corliss engines the seal is never very liberal and there is danger of the valve being partially open when in the extreme closing position.

Possibly when new valves were supplied for Mr. Gilliam's engine they were made wrong and do not match the ports. It is evident from the diagram that the head-end steam valve is open all the time, for when the exhaust valve closes the pressure rapidly rises, and on the steam line and expansion curve the evidence is that the steam continues to pass into the cylinder throughout the stroke. A sharp reversal of the pressure after exhaust closes causes the head end to pound. The crank end has excessive lead, and the expansion curve at the crank end indicates a leaky exhaust valve or piston.

Referring to the head-end diagram, why is it so much higher than the crank-end diagram and why does not the steam line rise above the admission line, showing the discharge of steam from the cylinder to the steam chest? It is possibly due to leaky exhaust on this end. It is possible that when the crank-end steam valve is open for admission and the head-end valve is open or leaking severely, the admission pressure on the crank end is reduced by a lowering pressure in the steam chest.

F. JONES.

Cincinnati, Ohio.

Care of Pipe-Line Valves

When valves become hard to open and close, some engineers use a wrench or bar without any thought of locating and correcting the defect. In the first place, the packing should be kept lubricated and should be renewed often enough to prevent leakage. Many high-pressure gate valves can be packed when wide open and under pressure.

The stems of rising-stem valves should be given an application of graphite and cylinder oil at regular intervals. If this attention does not correct the trouble, the stem may be binding at the threads. To overcome this, the threads should be given an application of valve-grinding compound, and the valve should be opened and closed a few times. The grinding compound should then be cleaned off with kerosene.

Gate valves sometimes work hard on account of binding between the wheel hub or nut and the yoke. The nut should be removed from the yoke and cleaned and, if necessary, dressed off with a file. Before being replaced, the nut should be coated with graphite and cup grease. For positive assurance against the trouble occurring again, drill an oil hole in the yoke or put on a grease cup. The engineer who keeps the valves in his care in good condition will have less hard work and will have made life and property safer in his plant.

Providence, R. I. C. P. LAWTON.

Maximum Length for Longitudinal Joints

It is with temerity that one would venture to criticize an opinion on boiler matters when given by such an eminent authority as the chief engineer of the Manchester Steam Users' Association. Steam engineers in America have felt greatly indebted to Mr. Stromeyer for the good work he has done in connection with boiler design and construction. However, some of the statements he makes in the article on page 626 of the Oct. 21, 1919, issue of *Power* would seem to need further explanation unless they are to be questioned by many practical engineers.

It may be true, as is stated, that the stress in the solid plate of an adjoining course near the end of a longitudinal joint is eight times that in the solid plate away from the joint, so long as the maximum stress concerned is within the elastic limit of the material. But it would seem to be evident from practice that this ratio between the stresses at the two points mentioned must undergo some marked change before the yield point or even the elastic limit of the material is reached.

It has been customary in this country to build nearly all shell boilers of any size in two or more courses. These boilers have generally operated at calculated factors of safety of from 4 to 5, with quite a few at a less factor than 4. Such safety factors, so far as the shell is concerned, are based on the calculated stresses assumed to exist in the longitudinal joints.

If the relation between the stresses at these joints and in the solid plate and opposite their ends were such as Mr. Stromeyer's test would indicate, the metal at the highest stressed points would fail. It would also appear from practical experience with boilers that the solid plate at the points specified cannot be stressed to or in any event beyond the elastic limit. The reason for making this statement is that wherever a portion of a boiler structure is excessively stressed, grooving or other form of corrosive action generally occurs. As far as the writer's own experience has gone, or from the experience of many other inspectors with whom he has been associated, he has never heard of any particular tendency to corrode at the location in question. From the behavior of boiler shells under hydrostatic test it would be surprising if a shell built in courses did not fail first at a longitudinal seam near the center of a course when placed under sufficient pressure to destroy it. Granted that this is so, it would appear that at some time between the first application of the pressure and the final rupture of the cylinder, the point of maximum stress would have to shift to the joint.

It is noted that reference is made to an unpublished destructive test experiment made by the Manchester Steam Users' Association on a full-sized boiler in the year 1874, the solid plate rupturing at the same time as the longitudinal seam failed, if the writer has properly interpreted the statement. Surely, Mr. Stromeyer does not intend to take the result of a single test of this kind to establish his theory! It is true that in boiler explosions the fractures—aside from the initial rupture—do not follow the lines of the greatest weakness, but generally occur in the solid plate. This result, however, has been assumed to be due to the fact that aside from the initial rupture the other breaks in the structure are supposed to be caused by water-hammer action produced by the rapid generation of steam throughout the mass of water, which is supposed to occur upon the sudden release of pressure.

It is stated in the article that no boiler with a factor of safety of 5 has ever exploded. This certainly cannot be true in the United States, and it would be interesting to learn what factors of safety existed in the few cases where boilers have exploded in England.

From Mr. Stromeyer's statement about the superiority of acid steel over that made by the basic process, it would seem high time that the laws and rules governing boiler construction in this country were being modified. If prohibiting the use of basic steel and the application of a safety factor of 5 in the construction of boilers will absolutely prevent boiler explosions, it is time we were getting on that basis. The safety factor of 5 is an accomplished fact now. It would, therefore, seem proper to use the right material and secure the same nearly 100 per cent immunity from boiler explosions that our English cousins enjoy.

As to the address which is referred to as read by an American engineer who qualifies as a boiler expert, owing to the fact that he has been present at a dozen boiler explosions and has experienced as many hair-breadth escapes, Mr. Stromeyer can rest assured that an engineer with such experience would be just as much of a curiosity in America as he would be in England. There have been a few explosions staged in this country for experimental purposes and some wrecks produced for movie thrills, but the audience in such cases has been amply protected. While it is possibly not polite to suggest it, it may be that this American was trying to put over a joke that his English audience would appreciate and made it a little too obvious.

It would seem to be futile to try to compare the number of boiler explosions in England and the United States without some idea as to the total number of boilers in operation in the two countries. However, it is likely true that there are fewer explosions per thousand boilers in England than in the United States. While better construction, which certainly must exist in the case of the average English boiler, may account in a measure for such differences, it would seem most likely that operating conditions were largely responsible for many of the explosions in this country. The lack of intelligent attention in the case of many boilers that are being operated in this country is appalling. No doubt the same may be said of many English plants.

Hartford, Conn. S. F. JETER.

Averaging Pressure Charts

On page 669 of the Oct. 28-Nov. 4, 1919, issue of *Power*, a method of averaging circular charts by the polar planimeter is related by Mr. White. This method consists in finding the area of such a chart in square inches and then determining the radius of a circle of equal area. This radius is laid off on the chart from the center to locate the average chart reading.

The method is only approximate, by the following reasoning: Let

r_o = Correct average radius of chart in inches.
r_1, r_2, r_3, etc. = Various radii at different times.
n = Number of radii taken to get an average.
r = Average radius as obtained by polar planimeter.

Now, obviously the correct average radius is

$$r_o = \frac{r_1 + r_2 + r_3 + \ldots . r_n}{n}$$

And

$$Area\ of\ chart = \pi \left\{ \frac{r_1^2}{n} + \frac{r_2^2}{n} + \frac{r_3^2}{n} + \ldots . \right\}_n$$

By the method described by Mr. White,

$$Area\ of\ chart = \pi r^2$$

Comparing the last two equations,

$$r = \sqrt{\frac{(r_1^2 + r_2^2 + r_3^2 + \ldots . r_n^2)}{n}}$$

and is not equal to r_o as given in the first equation. In other words, this method gives the square root of the mean of the squares of the radii instead of the arithmetical mean.

The method is good, however, as an approximation. It should be observed that the less the variation of the charted quantity the more nearly true is the result by the approximate method. If the variation is very wide, the method should not be used.

On page 260 of the Aug. 19, 1913, issue of *Power*, the writer gave some figures to show the percentage of error involved when getting mean values by the polar planimeter according to the system outlined by Mr. White.

JULIAN C. SMALLWOOD.

Baltimore, Md.

Boiler-Room Essentials

In the interesting article by H. F. Gauss, entitled "Boiler-Room Essentials," page 589, of the Nov. 22, 1919, issue of *Power*, the author made some statements about CO_2 equipment which lead me to suspect that he has not had experience with at least one of the efficient modern types of CO_2 recorders. Perhaps his experience was with early models, which admittedly do not compare with recent instruments in simplicity of operation and general satisfactory performance. Mr. Gauss appears to be laboring under the mistaken impression that CO_2 recorders involve extra labor, whereas my experience has been that, next to fuel saving, their principal advantage is in reducing the labor of the engineer and fireman, thus giving them more time to devote to other duties.

Mr. Gauss says: "In many cases the hand Orsat is more desirable than the CO_2 recorder, when the engineer on watch is required to make gas analyses at least once an hour and is required to see that these analyses show reasonable percentages of CO_2. That is, if he makes an analysis and finds the CO_2 low, he must at once determine the cause, have it corrected and secure the normal analysis. In large plants operating 10 to 20 boilers, this is not practicable and the recording apparatus must be resorted to with an expert devoting his entire time to the instruments in the boiler room."

Evidently, Mr. Gauss believes that the engineer should take CO_2 readings every hour when using an Orsat. At that rate there would be little time left to devote to other duties; in fact, taking readings so frequently would almost seem to require one man to devote his whole time to flue-gas analysis. Even then the time elapsing between the withdrawal of the gas sample and the completion of the analysis would prevent the engineer from correlating the information furnished by the analysis with the operating condition of the furnace. For instance, the CO_2 in the exhaust gases might be only 7 per cent at the instant that the gas is withdrawn and 12 per cent a few minutes later when the analysis is completed. A CO_2 recorder, on the other hand, furnishes the information continuously, thus enabling the fireman and the engineer to coöperate in keeping the percentage of CO_2 high all the time. The CO_2 recorder, working every second of the day and night, analyzes the gases better and cheaper than the engineer can do it, working in hourly periods.

The actual time required for attending to the CO_2 recording instruments with which I am familiar amounts to three or four minutes daily per unit, and less than one-half hour once a week for changing absorbent cartons and checking readings. The salary of a man required to attend an Orsat would pay for the installation and operation of an automatic recorder several times over in the course of a year.

Mr. Gauss states further that CO_2 recording equipment "must be resorted to" in large plants operating ten to twenty boilers, in which case an expert must be engaged to devote his entire time to the instruments. This statement is inaccurate so far as the successful types of instruments are concerned. Modern recorders are sturdy in construction and are no more difficult to use and keep in order than other types of boiler-room equipment. Ordinarily, they operate for years without other attention than occasional cleaning, say once or twice a year, and any mechanic can attend to this by following simple instructions. Far from requiring an expert, the successful modern types of CO_2 equipment are designed to avoid the necessity of expert attention. Any man who can understand and run a steam engine and its auxiliaries should have no difficulty with CO_2 equipment.

Mr. Gauss quite rightly approves of the use of the recording pyrometer. However, as the percentage of CO_2 fluctuates much more violently than the flue-gas temperature, the argument in favor of using recording equipment is even stronger in the case of CO_2 equipment than in the case of pyrometers.

C. J. SCHMID.

New York City.

Difference in Heating Systems

In answer to Mr. Molloy's letter on page 716 of the Nov. 11-18, 1919, issue of *Power* in regard to my heating-system letter in the June 3 issue, I will say that the radiators were controlled by a thermostat, which operated the radiator valves by compressed air. The vacuum was held steady after the building was once warmed up and the thermostats were operating.

The reason the pumps were set so high above the return main of the system was for show purposes only. This plant is used to furnish power, heat and light to a large manual-training school. Part of the course in training is operating engineering, and these pumps were put on the engine-room floor just for looks. This was a big mistake, which has been admitted since.

For the benefit of Mr. Downham I wish to say that I'll agree that the remedy would be to place the pumps in basement below the return main.

L. B. SHIELDS.

Chicago, Ill.

Size of Pipe for Boiler Feed

I have had considerable experience with boiler-feed lines in connection with the installation of a certain type of boiler-feed regulator, and it has been my experience that it is the usual custom to keep the velocity of water in the feed pipes below 200 ft. per min.

Answering Mr. Craft's question, page 781 of the Nov. 25, Dec. 2-9, 1919, issue, if a 4-in. pipe is used, a discharge of 60,000 lb. per hour will be equivalent to a velocity of 183 ft. per min., which is within the required allowance. If the pipe line is short and does not contain many fittings, it is possible that even a 3-in. pipe with a velocity of 325 ft. per min. might be used. This would be especially true if feed-water regulators having constant feed characteristics were used.

If an intermittent type of feed regulator or hand feeding is used, there are likely to be times when the feed is greatly in excess of the average, and the friction loss with the pipe, which will then be too small, will be considerable. Since this friction loss increases as the square of the velocity, it is evident that the discharge through the feed line should be kept as near as possible to the average. The best way is to install a regulator which feeds continuously in proportion to the load, and sometimes in inverse proportion to the load, depending upon conditions. This tends to reduce the friction losses in the pipe and admits of a smaller pipe being used for supplying the boiler.

Erie, Penn. V. V. VEENSCHOTEN.

What Happens When a Synchronous Motor Is Caused to Pull Out?

I have read with pleasure the interesting and instructive papers, by Will Brown, treating of the characteristics of the synchronous motor. The analogies are very clear and should enable the reader to readily comprehend the fundamental features both of construction and operation. There is one important point, however, which Mr. Brown, as well as others, touches upon very lightly, I may say even "gingerly." In his article in *Power*, issue of Sept. 2, 1919, he says:

> The force holding together the poles of the stator and the poles of the rotor suddenly snaps like a breaking rubber band, and the rotor stops, while the magnetic poles of the stator continue on at constant speed. This is what happens when a synchronous motor is overloaded and pulls out of step, and is called the motor's pull-out point. Of course, in actual practice the circuit-breakers will generally disconnect the line from the motor before it reaches this point, because of the enormous current that the motor would be pulling from the line.

He says further in the issue of Sept. 23:

> In Fig. 4 the load has literally pulled the rotor poles away from the stator poles. As soon as the point is reached where the north pole of the stator opposes the north pole of the rotor, the pull of the line snaps like a rubber band and the rotor is brought to a dead stop by the heavy pull of the load.

Now, it is known that something more than this really happens. It has been conceded by the electrical engineers of the two largest manufacturers of electrical equipment that there is a decided buck at this point, which, for the purpose of identification, we may call the "pull-out buck."

It is acknowledged by the electrical engineers before mentioned, that under certain conditions of line and load, which may and do occur in practical operation, this pull-out buck can take place at a point inside a reasonable setting of the circuit-breaker, say 150 to 175 per cent of full-load rating; that under these conditions the circuit-breaker cannot anticipate the pull-out, and because the buck is "instantaneous," the circuit-breaker does not relieve the reactive kick until too late; that the electrical "pile up" will be from eight to ten times the rated capacity of the motor; that the mechanical reactive stress impressed upon the cores on the periphery of the rotor will be from six to eight times the rated capacity of the motor.

Now this is of very great moment if it is true, and because no one seems to know just what does take place, it is of the utmost importance that the matter should be demonstrated to a conclusion that can be depended upon. Testing devices are being developed for this purpose and we may expect definite information on these points in the near future. In the meantime let us go over the "mechanics of the thing," which we can readily do, and see what may be the result. Let us take, for example, a 600-hp. synchronous motor, with a bad line swing, low voltage, a heavy load and a flywheel out of proportion for the conditions.

Now let us apply shock by introducing a liquid or a piece of metal into the compressor cylinder, and we have conditions under which, it is conceded, we may and do get an electrical angularity which will result in the motor "pulling out" inside the setting of the circuit-breaker. We will then have a pull-out buck.

Let us take the word of these electrical engineers and assume that the electric pile-up is ten times, and the electric reaction delivered across the air gap to the rotor is eight times the rated capacity of the motor. We then have at this instant a mechanical reactive stress at the "rim of the rotor," expressed as 4,800 hp., which is transmitted to the spokes of the rotor, thence through the hub and key to the shaft, then along the shaft, through the key, hub and spokes to the rim of the flywheel, where it is opposed by the inertia here provided, plus the compressor load.

It goes without saying, of course, that the initial stresses begin in the stator and are primarily impressed upon the "feet" and holding-down bolts. Now, then, if there is a weak link in this chain, and particularly if it is in the flywheel rim or spokes, something serious is bound to take place.

It is certainly not good engineering to let this matter drift along until we have an "accident" which may result in the loss of not only dollars and cents, but also human life. In the meantime it seems to me that we should anticipate by means of proper design and construction the stresses that may be logically expected. I want to say in this connection that I consider the flywheel an element of danger as well as expense, when used in conjunction with a direct-connected synchronous motor, and that, for the reason that it is entirely unnecessary, it should be eliminated from synchronous-motor drives. This can be accomplished with entire success if proper attention is given to rotor design.

F. L. FAIRBANKS, Chief Engineer,
Quincy Market Cold Storage and Warehouse Co.
Boston, Mass.

Reboring Corliss Valve Chambers

I have had quite an argument regarding the proper method of reboring Corliss valve chambers. When doing this work, should not the chambers first be lined up to show how much they are worn or out of line, and then have the boring bar set so as to rebore the chambers and bring them into line with the cylinder instead of just setting up the boring bar on the bonnet studs and calipering to bring the boring bar central?

How would readers of *Power* go about finding how much the valve chambers were out of line with the cylinder, and how would they set the boring bar?

New York City. MICHAEL J. MURPHY.

INQUIRIES OF GENERAL INTEREST

Left-Hand Adjusting Screw of Monkey Wrench—Why are monkey wrenches usually provided with left-hand adjusting screws? T. W.

A left-hand adjusting screw affords greater convenience in closing up the jaws of the wrench by operation of the milled collar with the thumb, while the wrench is held in the grasp of the fingers of the right hand.

Poor Circulation in Radiator of Vacuum System—In a vacuum heating system that supplies heat for two houses, there is heating up of only about one-third of the number of sections of a radiator in the building farther removed from the boiler. What may be the cause and remedy? R. A.

The cold sections probably remain airbound due to insufficient vacuum. If it is not possible to obtain a better vacuum at the return while the steam supply is open, the air might be dislodged, sufficiently for starting operation of all sections, by exhausting the radiator with the best vacuum obtainable for ten or fifteen minutes prior to admission of steam.

Percentage Improvement in Coal Economy per Kilowatt-Hour—Our fuel consumption for October was 1,960,010 lb. of coal costing $7.44 per ton of 2,240 lb. for an electrical output of 524,270 kw.-hr. For December the fuel consumption was 1,746,445 lb. of coal costing $7.44 per ton of 2,240 lb., and 690,260 lb. of screenings costing $1.50 per ton of 2,000 lb. for an electrical output of 574,040 kw.-hr. What was the percentage of improvement in coal economy? G. A. E.

For October the fuel cost was

$$\frac{1{,}960{,}010 \times \$7.44}{2{,}240} \div 524{,}270 = \$0.01242 \text{ } \textit{per kw.-hr.}$$

For December the fuel cost was

$$\left[\frac{1{,}746{,}445 \times \$7.44}{2{,}240} + \frac{690{,}260 \times \$1.50}{2{,}000}\right] \div 574{,}040 = \$0.01101 \text{ } \textit{per kw.-hr.}$$

Hence for December the improvement in coal economy over that for October was

$$\frac{(\$0.01242 - \$0.01101) \times 100}{0.01242} = 11.35 \text{ } \textit{per cent.}$$

Direction of Setting Globe Valve—What is the proper way to place a globe valve, to have the pressure under the disk or on top of the disk? H. P.

For most situations, especially for large globe valves or for high pressures, it is preferable to have the pressure under the disk, as that method permits packing the valve when closed and prevents the accident of the valve stem pulling out of the disk when the valve is opened under pressure. Another advantage of having the pressure under the disk is that the direction of flow results in less abrasion of the valve seat. The principal advantages of having the pressure on top of the disk are that the pressure holds the disk to its seat; also that when the line is allowed to cool down with the valve closed, the lost motion between the disk and the spindle permits the disk to follow up the contraction of the valve body and when steam is again turned into the line the valve is as tight as before, whereas with steam reintroduced on the seat side of the valve, there is leakage until the valve has become reheated and reëxpanded to its former dimensions, and to close the valve down tight before it is warmed up makes it harder to open after the expansion has taken place.

Reactive Factor—What is the reactive factor of an alternating-current system, how is it determined, and what relation has it to the power factor? M. O. W.

The reactive factor of an alternating-current circuit is the sine of the angle of lag or lead between the current and voltage. If the power factor is read from an instrument or calculated by dividing the watts by the volt-amperes, reference can be made to a table of natural sines and cosines and find the sine of an angle corresponding to the cosine that is the power factor. For example, if the power factor is 0.86, this is the cosine of a 30-deg. angle and the sine of 30 deg. is 0.5, therefore the reactive factor is 0.5 when the current is out of step with the volts by 30 degrees. When the current and volts are in phase, the power factor is 1.00 where the reactive factor is 0. Another way of determining the reactive factor is by the formula:

$$\textit{Reactive factor} = \sqrt{1 - \left(\frac{\textit{Watts}}{\textit{Volt-Amperes}}\right)^2}$$

The volt-amperes times the power factor equals true watts, where the volt-amperes times reactive factor equals the reactive component of the volt-amperes or, the volt-amperes that is being transmitted back and forth through the circuit doing no useful work.

Determining Size of Feed Pump—What size feed pump should be supplied for a 100-hp. boiler? E. A.

A standard boiler horsepower is the equivalent evaporation of 34.5 lb. of water from and at 212 deg. F. per hour, and as the actual conditions usually are such that the equivalent transfer of heat is accomplished by evaporation of a less quantity of water per hour, under normal conditions it will be on the side of safety to assume feed-pump capacity on the basis of 34.5 lb. But to cover operation of a boiler 50 per cent beyond its rated capacity, and extraordinary demands in case of low water or other emergencies, the rated capacity of the pump should be not less than 90 lb. of water per hour per rated horsepower of the boiler, and the pump capacity should be rated at no greater piston speed than about 50 ft. per minute.

At ordinary temperatures a cubic foot of water weighs 62.3 lb., so that a boiler-feed pump should have a displacement capacity of $\frac{1728}{62.3} \times \frac{90}{60}$ = about 42 cu.in. per min. per rated boiler horsepower capacity, and the pump piston speed of 50 ft., or 600 in. per min., would require $\frac{42}{600} = 0.07$ sq.in. of water-piston area per rated boiler horsepower. Hence, for a 100-hp. boiler the required area would be $100 \times 0.07 = 7$ sq.in., and neglecting the area occupied by the piston rod this corresponds to $\sqrt{\frac{7}{0.7854}} = 2.98$, or practically 3 in. diameter for a single pump, and $7 \div 2 = 3.5$ sq.in., which corresponds to $\sqrt{\frac{3.5}{0.7854}} = 2.11$, or practically 2 in. diameter for water cylinders of a duplex pump.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Electrically Operated Pumping Plants in Indiana*

ACCORDING to available records there are 206 public water-works systems in the State of Indiana. Seventy-six of these, more than one-third, are operated partly or wholly by electricity. During the past winter and spring twenty-seven of those plants were visited by members of the Engineering Experiment Station staff of Purdue University with a view to ascertaining the present status of electrical operation of such plants.

The plants visited supply water to communities ranging in population from 500 to 25,000 and were found to be operating under a variety of conditions. Fifteen plants used some form of elevated storage—tank, standpipe or reservoir; six were provided with compression tanks, the pressure being automatically controlled by pressure gage relays, while the remaining six had no provision for storage but maintained direct pressure by continuous operation of the pumps. This probably represents in a general way the distribution as to types of plant over the state as a whole.

About 20 per cent of the plants visited made use of deep-well pumps—air lift or displacement. The remainder used surface pumps, though in many cases the pumps were placed in pits from 4 to 15 ft. below ground level in order to reduce the suction lift.

The most commonly encountered source of water supply was the drilled well, 6 to 10 in. in diameter, and from 100 to 300 ft. deep. In a few cases the supply came from streams of spring-fed reservoirs, but these were exceptional. The water from wells appears to be, in general, clear and pure; requiring no outlay for purification equipment. In most localities the water stands from 10 to 20 ft. below ground level, but in a few places it flows to the pump under sufficient head to eliminate entirely the necessity for priming.

Centrifugal pumps and triplex displacement pumps were encountered in about equal numbers and the plant that contained neither of these types was exceptional. One rotary pump was observed, handling the second stage of a two-stage system; and the City of LaFayette has three direct-connected motor-driven propeller pumps forming the first stage of a two-stage system, the second being handled by steam pumps. These, however, are held for emergency use, the first-stage pumping being normally done by air-lift. Also in one case the first stage was handled by motor-driven deep-well pumps and the second stage by steam pumps. In 75 per cent of the plants inspected, however, the single-stage system was used.

Alternating-current energy was utilized in practically all cases, either because direct current was not available or because the alternating-current motor is cheaper, more rugged and requires less attention. Various types of alternating-current motors were found to be in use, however, the choice depending chiefly upon the type of pump to be driven. In most cases the available energy supply is 60-cycle three-phase current, and the choice lies between the squirrel-cage and the wound-rotor types of induction motor, the former being used for driving centrifugal pumps where the starting load is light, and the latter for driving displacement pumps where the starting load is relatively heavy. Exceptions were noted, however, to this general rule, and in one case synchronous motors were found giving very satisfactory service. Single-phase, 25-cycle motors were encountered in one plant, the energy being obtained from an interurban railway transmission line which passed through the town.

For domestic service the pressures in use were found to range from 25 to 90 lb. per sq.in., the average being about 40 lb., corresponding to a head of 93 ft. In many cases provision is made for raising this pressure for fire-fighting purposes to 90 or 100 lb. by cutting off the storage and bringing a special high-pressure unit into service. It is not uncommon to find steam pumps used for securing the extra pressure needed for fire service, though the motor-driven fire-service pump is popular in localities where auxiliary steam equipment would be expensive to provide and maintain. There appears to be a growing sentiment in favor of securing the extra pressure by using a portable pump at the location of the fire, rather than by boosting the pressure over the whole system, thereby making both mains and plumbing liable to damage or even complete failure at a time when such failure would be most serious. This method also eliminates the extra demand for water at service connections during the high-pressure periods when the greatest possible supply should be available for fighting fire.

For domestic service the average pump capacity provided was about 200 gal. per min., per 1,000 population, but this figure is not of great value since the capacity required depends largely upon local conditions and may vary widely for towns of the same population. Also, the system used has considerable influence upon the pump rating. A direct-pressure system must have sufficient capacity to supply the peak of the load, while in a storage system the pump needs to supply only the average demand, anything above this being drawn from the storage. The tendency is to provide too much rather than too little capacity, in order to be on the safe side and to provide for future requirements. The pumping units designed for special fire service average about 250 gal. per min. pump capacity per 1,000 population. These units also provide reserve capacity for abnormal demands other than for fire service.

Officials and operating men expressed themselves almost unanimously as well pleased with the results obtained through use of electrically operated equipment. Appreciation of the greater convenience and decreased operating expenses was especially marked in places where the pumps were previously steam driven. One plant was visited in which steam operation had been resumed after a trial of electric operation, but no one available at the time could give an adequate reason for the dissatisfaction with the electric drive.

Another case was encountered, where a direct-connected motor-driven centrifugal pump was giving unsatisfactory service, though no blame was placed upon the motor itself. The pump was obviously not designed for the conditions under which it was working, and the result was an energy consumption greatly out of proportion to the work done. Plans were being made to replace the centrifugal with a triplex pump, though it appears likely that a change in impellers would have accomplished the same result. This serves to emphasize the necessity for using great care in specifying a centrifugal pump for a given application, in order that its characteristics may be suited to the work it is expected to do.

Numerous cases of minor troubles with the equipment were reported. Of these directly chargeable to electric operation the only ones of serious import were those due to lack of adequate protective devices between motor and line. Some of them involved no serious consequences, while others involved considerable expense and inconvenience, as well as fire risk. It would appear that the necessity for adequate protection of the motor and control circuits is not generally appreciated. The cost of such protective apparatus is not great and will soon be repaid through decreased repair bills and greater reliability of the equipment. Troubles were reported due to lack of reliable low voltage and no-voltage cutouts and also to lack of proper protection against lightning. Good lightning-arrester equipment properly installed is essential where power is secured from a transmission line and is the only means of preventing damage from this source, which may vary all the way from a breakdown of insulation in one or more coils to destruction of the entire electrical equipment.

Next to having the apparatus itself it is of importance that attendants should understand the significance of the protective devices. One plant was visited where no voltage protection was provided, but a former attendant had decided that by wedging the starting handle in the full-on position he could start the pump from the power station and save himself a half-mile walk. Unfortunately, the motor windings did not survive the initial experiment, but had to be entirely replaced.

Other than electrical the most frequent source of trouble appeared to be due to freezing in severe winter weather. Bursting of pump cylinders was reported in numerous instances. In some cases these breaks had been repaired by

*Presented at the annual meeting of Indiana Engineering Society in Indianapolis, Jan. 23-24, by G. C. Blalock, instructor in electrical engineering, Purdue University, LaFayette, Ind.

welding; in others the cylinder had to be replaced. Troubles from this source can be charged only to neglect in providing some means of keeping the temperature sufficiently high to prevent freezing.

The installation of cheap equipment invariably results in troubles due to excessive wear and breakage; and poor judgment in the selection and use of equipment augments the difficulties along this line. In one plant the first stage was handled by an air lift and the second by a cheap rotary pump. The latter was driven at such high speed that it handled water faster than the air lift could supply it, so a portion was bypassed and pumped over again. In addition the wear on the impeller was so great as to necessitate its renewal two or three times each year.

Troubles due to flooding sometimes occur in plants having the pumps located in pits. Unless the motor windings have been thoroughly waterproofed, they are sure to be more or less permanently damaged, with consequent shortening of their useful life, although the damage may not be such as to require immediate rewinding.

Improper alignment of pump and motor causes undue wear and results in decreased efficiency and increased maintenance cost. The same cause sometimes results in broken rods in case of deep-well pumps. Corrosion and rapid wear due to sediment in the water being pumped were reported in one or two instances.

Only six of the towns visited had provision for metering the pump discharge, despite the obvious advantage of having this means of checking the performance of the pump and motor. With a watt-hour meter on the input side of the unit and a water meter and pressure gage on the output side, the duty and over-all efficiency may be determined readily at any time and any marked drop detected and accounted for. A centrifugal pump particularly needs to have its performance checked to avoid the marked drop in efficiency that occurs when the impeller is not properly designed for the conditions under which it is working. The substitution of an impeller of slightly different design may effect a saving that will pay for both meters and impeller within a comparatively short time.

Plant Operating Records and Costs

It was found rather difficult to obtain accurate records of plant operation and costs, particularly in the smaller towns. Combined power and pumping plants frequently do not provide separate meters for measuring the energy supplied to the pump motors nor divide the operating costs equitably between the power and pumping departments of the plant. Where energy is obtained from sources not owned or controlled by the interests operating the pumping plant, the meter provided often includes the energy used for street lighting, station lighting and heating or other purposes; and as previously mentioned, it is not often that provision is made for measuring and recording the amount of water pumped. The data obtained therefore involve estimates in many cases and should be considered as indicating plant performance in a general way only.

Data for calculating energy consumption per 1,000 gal. of water pumped were obtained for fourteen towns. In kilowatt-hours per 1,000 gal. this energy consumption ranged from a minimum of 0.20 to a maximum of 3.28, giving an average value for the fourteen towns of 1.31.

Since there is considerable variation in the total head against which these pumps are working, a better measure of performance may be obtained by reducing the figure given for each plant to a basis of 100 ft. total head. This gives values ranging from 0.125 to 1.96 with an average of 0.90 kw.-hr. per 1,000 gal. per 100-ft. head.

The operating cost per 1,000 gal. was found to range between 0.88 and 16.83c., with an average value of 4.97c. Reduced to a basis of 100 ft. head this average becomes 3.74c. per 1,000 gal.

Test Data from Specific Plants

Two plants equipped with meters for measuring the pump discharge were selected, and tests were run, with two objects in view: First, to determine the duty and over-all efficiency of the pumping unit, thus obtaining a basis for figuring energy costs per unit discharge; and second, to determine the nature of the power demand and thereby establish the degree of desirability of pumping loads from the central-station point of view. The test in each case extended over a period of 24 hours, and in addition to kilowatt-hour and water meters a graphic recording wattmeter was used for measuring and recording the power demand.

In the first plant the unit tested consisted of a 2½-in. single-stage, 175 gal. per min. centrifugal pump, driven by a 15-hp. squirrel-cage type induction motor, pumping continuously against the direct pressure of the mains. A total pumpage of 11,900 cu.ft. was observed—an average rate of 61.8 gal. per min. against a pressure of 40 lb. per sq.in. with an input of 9.38 hp., giving an over-all efficiency of 16.7 per cent. Estimates based upon pipe-friction tables give about 10 ft. loss of head in elbows, valves, meter, etc., between the pump intake and the point at which the pressure gage was attached to the main. Including this loss of head raises the efficiency about 2 per cent. This still gives a low over-all efficiency, but it should be noticed that the pump is discharging but little more than one-third of its rated capacity, this resulting in the motor running at considerably less than its normal rating. Neither pump nor motor can therefore be expected to show good efficiency. It is evident that this unit is not operating under the conditions for which it was designed, resulting in high energy consumption per unit output.

In the second plant the unit tested consisted of a 4-in. two-stage, 380 gal. per min., centrifugal pump, driven by a 25-hp. squirrel-cage type induction motor, pumping to mains, with standpipe storage. The frequency and duration of pumping periods were regulated by a pressure-gage relay and an automatic motor starter.

Three runs of approximately two hours each, at an average pressure of 55 lb. per sq.in., gave a pumping rate of 350 gal. per min. with an input of 32.25 hp., showing an over-all efficiency of 38 per cent. Estimated loss in head due to friction amounts in this case to about 35 ft., and inclusion of this loss as part of the total head raises the efficiency about 10 per cent. The over-all efficiency checks closely with manufacturers' estimates for this size and type of unit and the unit is evidently well adapted to its work.

The conclusions arrived at as a result of investigation and study of the present status of electricity in the pumping plants of the state may be summed up as follows:

1. Where local conditions have been carefully considered, the type and capacity of pump and motor which best suits those conditions intelligently selected, electrically driven pumps have proved highly satisfactory; they have been found to be easily handled, convenient, reliable and economical.

2. While the motor itself is unlikely to give trouble, and transmission lines have proved quite reliable, it appears advisable to provide some auxiliary source of power. The automobile-type gasoline engine seems particularly well suited to this purpose.

3. The energy consumption in properly designed plants may be expected to vary from 0.2 to 2 kw.-hr. per 1,000 gal. per 100 ft. head, with 1 as a fair average.

4. The operating expenses for an electrically operated plant are low—considerably below those for a steam plant and appreciably below those for an internal-combustion engine plant.

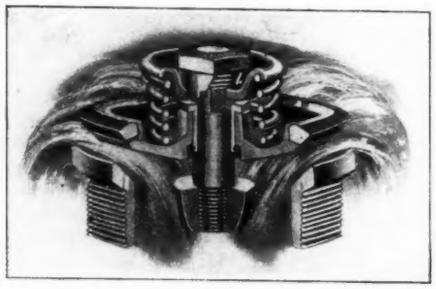
5. The pumping-plant load is a desirable one from the central power-station point of view.

Peter Cooper Hewitt has, says the Springfield, Ohio, *Sun*, developed a new machine which, he claims, will do even more than the required performances to win the $100,000 prize offered by the Michelin Co. for a machine that will rise straight into the air without a preliminary run and will land in a space 30 ft. square. According to Mr. Hewitt, with his new propeller it will be possible to reverse the plane while in flight without reversing the engine or turning about. It can also be made to leap or drop like a flying boat. These unusual movements are made possible by the odd propeller which may be pointed in any direction, and the entire force of the blades is applied to lifting. Once in the air, the shaft is pointed forward and the machine moves ahead with a speed that equals the best attained by other machines. At any time during the flight the position of the propeller may be changed.

Condensed-Clipping Index of Equipment

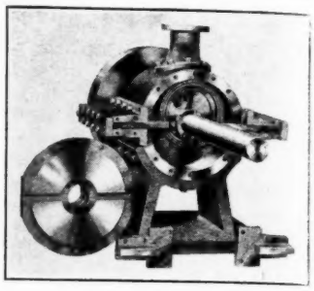
Clip, paste on 3 x 5-in. cards and file as desired

"No Kut" Pump Valve
Richardson-Phenix Co., Milwaukee, Wis.
"Power"



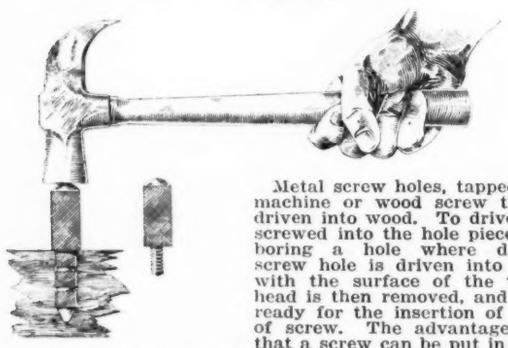
A new pump valve designed to eliminate leakage and slippage. The metal valve disk seats on a metal surface. The valve disk is fitted with a composition sealing ring around its outer edge and one around the valve stem. These sealing rings, being flexible, are forced against the valve seat by the pressure of the liquid as the valve closes. The greater the pressure of the liquid the tighter the valve is seated. Owing to the composition of which they are made, the sealing rings are durable, and no matter how badly the seating surface of the valve becomes worn, scarred or scored, the rings keep the valve tight.

Engine, Bannon Rotary Steam
Bannon Rotary Motor Co., 324 Linz Building, Dallas, Tex.
"Power"



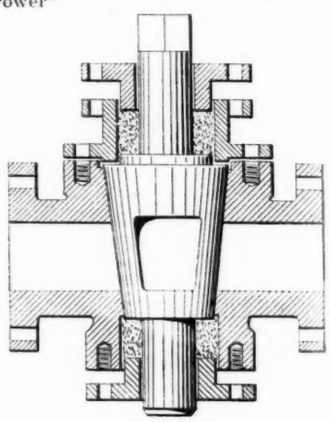
The Bannon rotary steam engine has but three moving parts: An eccentric piston keyed to the driveshaft, and two sliding gates which operate with their ends forming a contact with the periphery of the piston. On the shaft of the two-cylinder engines there are two of these eccentric systems, set 180 deg. apart, which balance the shaft and eliminate the possibility of dust on the bearing surface. The principle of the lever is employed by having the steam expand against a revolving eccentric system so that the leverage of the system greatly multiplies the steam energy. Each impulse of steam drives the shaft three-quarters of a revolution, and as there are two impulses per revolution in each cylinder, an overlap of 90 deg. results. The engine can be coupled directly to the lineshaft.

Holes, Stine Screw
Stine Screw Holes Co., Waterbury, Conn.
"Power"



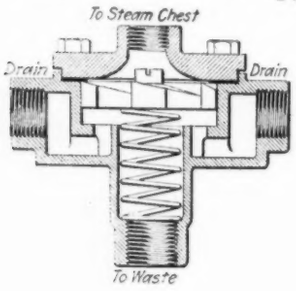
Metal screw holes, tapped for either machine or wood screw threads, are driven into wood. To drive, a head is screwed into the hole piece, and after boring a hole where desired, the screw hole is driven into place flush with the surface of the wood. The head is then removed, and the hole is ready for the insertion of either type of screw. The advantage of this is that a screw can be put in or removed as often as desired without enlarging the hole. These screw holes can also be molded in any material.

Cock, Double-Packed Stop
M. H. Treadwell Co., Inc., 140 Cedar St., New York City.
"Power"



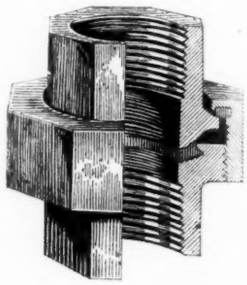
This stop-cock is packed on top with asbestos, sprinkled with graphite, both ends of the packing rings fitting close together. The top gland is then tightened so that the plug will barely turn, after which the bottom is packed in the same manner, the packing being drawn tight enough to release part of the pressure at the top. This equalizing of the pressure will enable the stop-cock to turn freely. It is built for high pressure.

Valve, Dielmore Automatic Drain and Relief
Dielmore Valve Co., Box 674, Tacoma, Wash.
"Power"



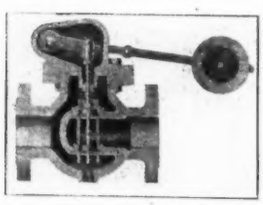
This valve is designed to automatically take care of the condensation in engine and pump cylinders after the steam has been shut off at the throttle valve. It is connected to the two ends of the cylinder and at the top to the steam chest. It contains a valve disk and spring. The pressure from the steam chest closes the valve against the pressure of the exhaust. When the throttle valve is closed, the pressure from the steam chest is removed and the spring opens the valve to allow the water to escape from the cylinder.

Union, Codd Double-Bronze Seated
The Codd Tank and Specialty Co., 406 W. Camden St., Baltimore, Md.
"Power"



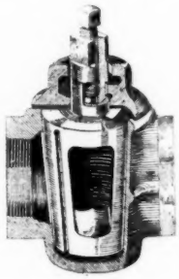
This malleable-iron pipe union is made with two bronze seats. One seat is fitted in the main body of the union and the other is in the nut, thus giving a double security against leakage. The two bronze seats are compressed into recesses, as shown.

Regulator, Improved Copes
Northern Equipment Co., Erie, Penn.
"Power"



The new control valve used with the Copes regulator has abandoned the reciprocating stuffing-box and in its place is a horizontal shaft which rotates slightly, the frictional resistance having been reduced as much as 6 to 16 lb. The valve is of the balance type, and the weight of the valve lever exerts a constant closing force of 50 lb. on the valve piston. A weight is used instead of a spring. The thermostat tubing is hollow, the water level corresponding to that in the boiler acts on the temperature of the rod, thus lengthening and shortening the tube as the water rises and falls, the expansion actuating a control valve.

Valve, Nordstrom Lubricated Plug
Merrill Metallurgical Co., 121 Second St., San Francisco, Calif.
"Power"



The special feature of this valve is that it is lubricated, the lubricant being placed at the top of the plug. It is forced out through the grease ducts by the lubricating screw shown in the center of the plug head. As the grease is forced out of the grease ducts, it is also forced into the grease chamber at the bottom and the plug is thus lubricated.

Patented Aug. 20, 1918

Sierra and San Francisco Properties Leased

The California Railroad Commission has approved the lease by the Sierra & San Francisco Power Co. of its properties to the Pacific Gas and Electric Co. The lease is to run for a period of 15 years, dating from Jan. 1, 1920. In addition to paying all taxes and governmental charges, providing for special funds created by the lease and setting aside 2 per cent of the gross revenues received from the leased properties for depreciation, the gas company is to pay a rental of $50,000 a year for two years, $100,000 for the third and $150,000 for each of the remaining years of the lease.

Pointing out that for nearly two years the Sierra & San Francisco Power Co. has been unable to sell its bonds and thus handicapped has not been able to install very necessary power plants and transmission lines, Commissioner Irving Martin, who wrote the opinion accompanying the order of approval, calls attention to service improvements that will follow as a result of the lease. He says:

"Considerable preliminary work has been done toward the installation of the so-called Spring Gap plant on the Stanislaus River. Material has been ordered for a second transmission circuit from Port Marion to Salinas in order to improve the service conditions in Salinas and other territory served by the Coast Valleys Gas and Electric Co., which buys its energy from the Sierra company. Material has been ordered to strengthen the line from Manteca to Modesto, thence interconnecting from Modesto to Newman, with provisions for an additional line to Turlock. Work has already been started by the Sierra company on an additional pipe line to its Stanislaus plant. The estimated cost of these projects is in excess of $1,000,000."

The Sierra & San Francisco Power Co. sells and distributes water in Tuolumne County and electric energy in the "Mother Lode" district of Tuolumne and Calaveras counties; in Stanislaus, San Joaquin, Contra Costa, Alameda, Santa Clara, San Benito and Monterey counties and the City of San Francisco. It supplies power to the United Railroads of San Francisco; 62 per cent of its earnings form the sale of electricity coming from the street-railroad company.

Sampling Atmosphere by Airplane

In the investigation of the atmospheric conditions and the smoke problems of Salt Lake City progress is reported by Osborn Monnett, who has had direct charge of the work.

FIG. 1. FIELD EQUIPMENT FOR SO_2 DETERMINATION IN ATMOSPHERE

The fuel survey, begun in September, has been completed, together with Ringelmann chart readings of the various classes of plants giving out smoke. Laboratory experiments with household equipment have been carried on throughout the winter. The information obtained therefrom is to be used in personal instruction of householders in the operation of their furnaces. A house-to-house canvass of the city has been made by the Boy Scouts in coöperation with the Federated Women's Clubs, and the number of different types of heating equipment used in the city is being tabulated to facilitate the work of instruction.

In connection with the examination of the atmosphere with respect to the influence of the smelter gases, the airplane has been used. This is the first time on record where the heavier-than-air machine has been used for this purpose. Samples are collected at the 3,600-ft., 2,200-ft. and 1,000-ft. levels, and these, in connection with samples taken on the roofs of the buildings and at the street level, will give determinations at the various levels affecting the situation.

J. J. McKetteridge, an engineer from the United States Bureau of Mines Station at Minneapolis, has been temporarily

FIG. 2. CHEMIST WITH FIELD KIT READY TO TAKE SAMPLES AT HIGHER LEVELS

transferred to the Salt Lake Station. He is an expert domestic boiler and furnace man and will be used to organize the work of personal instruction to owners of domestic equipment. During the month of February engineers of the Salt Lake Station are conducting a campaign of demonstration of smoke-abatement possibilities in large heating plants.

Future Organization for "Welfare" Activities of Engineering Societies

By whom and how shall the "welfare" activities of American engineers be conducted henceforth? This question has been much debated. For several months the report of the Joint Conference Committee of the Founder Societies (Civil, Mining, Mechanical, Electrical) has been before the societies as the answer. Decision will vitally affect the Engineering Council.

The Engineering Council at its meeting Oct. 16, 1919, received the Joint Conference report, and voted unanimously that Council indorses the general plan for a national Engineering Council as therein outlined. Nevertheless, the Council as now constituted must "carry the torch" until taken by the next runner. The torch must be kept burning. The Council, in the desire to further the interests of engineers and to remove difficulties in its own operations, invited the governing bodies of its member societies to a conference. Members of the Joint Conference Committee and the Trustees of United Engineering Society also were invited.

This conference met in Engineering Societies Building, New York, Jan. 23, from ten in the morning until five in the afternoon. It was the first time that the members of the governing bodies of these national societies had been brought together. It was an educative and otherwise profitable meeting. Its discussions were made effective in the resolutions copied below, it being understood that these actions were in the nature of recommendations to the societies.

Resolved, That the amount contributed for Engineering Council by each founder society shall be $5,000 for the year 1920, in place of $3,000 as now provided, and by the American Society for Testing Materials, $1,000, instead of $600.

Whereas, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers have adopted in principle the essential recommendations contained in the report of the Joint Conference Committee of the four founder societies; and

Whereas, It appears probable that the other founder societies will shortly also adopt the principles of this report; and

Whereas, It would be most unfortunate to permit certain

welfare measures of importance alike to engineers and to the public to be interrupted through lack of necessary immediate financial support; be it

Resolved, By this joint conference of the governing bodies of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials that appeals for contributions of $2 per person for the support of such welfare work during the interval before the recommendations of the Joint Conference Committee shall have been made effective, be sent at their discretion by the governing boards of the societies represented at this conference, to members of all grades, except juniors and student members; and be it further

Resolved, That the appeal make clear the fact that unless engineers lend financial support immediately, the public welfare work of engineers will be seriously discredited; and be it further

Resolved, That if the amount received by each society in response to the appeal be in excess of its appropriation voted for Engineering Council, such excess shall be appropriated by each society to Engineering Council or its successor.

Whereas, This Conference of national engineering societies has considered the recommendations of the Joint Conference Committee of the four Founder Societies; therefore, be it

Resolved, That the Conference adopts in principle that report and requests the Joint Conference Committee to call, without delay, a conference of representatives of national, local, state and regional engineering organizations to bring into existence the comprehensive organization proposed.

Voted: That if *this* Conference be called together again, it be called for a meeting in Chicago on Apr. 20.

Willful Waste Makes Woeful Want

There has been a fire burning on the waterfront of the Hastings Mills on Burrard Inlet for twenty-five years. Through rain and storm and winter and summer the flames burn brightly and the black smoke rises. Ever since the mills started there has been this bonfire, fed by the endless sawdust carriers. Hundreds of tons of wooden particles have been burned at this plant alone. At other mills throughout the province the sawdust is treated in the same way. As sawdust has a low commercial value and no one mill produces enough of the material to make a paying proposition of preparing it for various marketable uses, it has been allowed to go to waste for many years. It is thought now, however, that with many mills operating within a reasonably small radius there is enough being produced to make a sawdust-handling plant a good investment. It can be pressed into bricks or manufactured into dyes or other chemical properties extracted. The matter is being investigated by capitalists, and it is entirely probable that some steps will be taken this coming spring or summer to make use of sawdust waste from British Columbia mills.

World's Production of Petroleum

Country	Production, 1918: Barrels of 42 gallons	Metric tons	Per cent of total	Total production, 1857-1918: Barrels of 42 gallons	Metric tons	Per cent of total
United States	355,927,716	47,457,029	69.15	4,608,571,719	614,476,230	61.42
Mexico	63,828,327	9,506,289	12.40	285,182,489	42,564,549	3.80
Russia	40,456,182	5,520,066	7.86	1,873,039,199	247,856,218	24.96
Dutch East Indies a.	13,284,936	1,836,914	2.58	188,388,513	25,465,114	2.51
Rumania	8,730,235	1,214,219	1.70	151,408,411	21,058,193	2.02
India b	8,000,000	1,066,667	1.55	106,162,365	14,154,982	1.41
Persia	7,200,000	b1,000,000	1.40	14,056,063	2,952,231	.19
Galicia	5,591,620	777,640	1.09	154,051,273	21,424,303	2.05
Peru c	2,536,102	338,147	.49	24,414,387	3,255,251	.33
Japan and Formosa	2,449,069	326,543	.48	38,408,247	5,133,100	.51
Trinidad	2,082,068	289,578	.40	7,432,391	1,033,712	.10
Egypt	2,079,750	277,300	.40	4,848,436	646,458	.07
Argentina	1,321,315	192,612	.26	4,296,093	617,176	.06
Germany	711,260 b	100,000	.14	16,664,121	2,254,974	.22
Canada	304,741	40,632	.06	24,425,770	3,256,769	.33
Venezuela	190,080	26,400	.04	317,823	44,142	
Italy	35,953 b	5,000		973,674	138,588	
Cuba	.....	.....	.....	19,167	2,662	.02
Other countries	.....	.....	.....	397,000	55,139	
	514,729,354	69,975,036	100.00	7,503,147,138	1,006,389,791	100.00

(a) Includes British Borneo. (b) Estimated. (c) Estimated in part.

Tests on Slag Wool for Steam-Pipe Covering*

In these tests dry steam is admitted to a 4-in. steam pipe of outside diameter 4.47 in. and length 13 ft. 8¼ in. between the insides of the flanges. The pipe is set nearly horizontal, a slight fall being given toward the outlet end to facilitate the draining off of the condensed steam. Steam is admitted at the upper end through a gravity separator to insure the supply of dry steam. The condensed steam is collected in a down tube at the lower end of the pipe and the level of water in this collecting pipe is shown by a gage-glass. During the test the water is maintained at constant level by adjusting the drain cock. The water is passed through a cooling coil before passing out into the open air in order to prevent reëvaporation on reduction of the pressure. To allow for the condensation due to the flanges, the test pipe is removed, and a pair of similar flanges, with a very short length of pipe, is put between the ends of the apparatus. The amount of condensation obtained under these conditions is subtracted from the amount obtained with the test pipe in place. After a preliminary heating of some hours, says *The Engineer,* the pressure of steam is kept as constant as possible and observations taken for one hour. Two such one-hour runs with the pipe bare and covered respectively constitute a test. The observations taken during each hour include (1) the temperature of the steam at the inlet to the test pipe; (2) the air temperature at two positions, about 4 ft. from the pipe; (3) the temperature of the outside of the cover; (4) the weight of steam condensed.

Tests were made with two different thicknesses of slag wool covering held to the pipe by metal sheets, having distance pieces to fix the thickness of the cover. In each case the length of cover and area of pipe covered was 13.69 ft. and 16.02 sq.ft. respectively. The details of the covers are as follows:

	Cover No. 1	Cover No. 2
Nominal thickness	2 in.	1 in.
Weight per foot run	7.99 lb.	4.04 lb.
Weight per square foot	6.83 lb.	3.46 lb.

The difference between the net loss from the covered pipe and the bare pipe gives the heat saved per hour and the efficiency of the cover is taken as the ratio of this to the net bare pipe loss. The heat loss per square foot per hour per degree difference of temperature between the steam and the outside air is nearly constant for medium and low pressures of steam, but generally rises for high pressure; it is, however, the most convenient number for calculation of the loss under different conditions, so long as the conditions are not greatly different from those of the test. It may be noted that there is no flow of steam through the test pipe, except a very small amount due to the condensation. Hence in practice, where there is flow, the quantity of heat lost for the same difference of temperature between steam and air would not be the same as in the test pipe, but this will not materially affect the efficiency figure, since this is the ratio of two tests under nearly identical conditions. In the results given below, the gage pressure is the pressure corresponding to the steam temperature less the atmospheric pressure. The results for the bare and covered pipe are indicated at A and B, and the difference between these results is shown at C.

Cover No. 1		Test No. 1	Test No. 2	Test No. 3
Gage pressure, lb. per sq. in.		54.1	107.8	258.9
Temperature of steam, deg. F.		301.5	342.5	408.9
Temperature of air, deg. F.		67.3	67.4	62.2
Temperature of cover, deg. F.		81.0	88.4	87.8
Difference between steam and air temperature		234.2	275.1	346.7
Loss per square foot per hour per deg. difference of temperature deg. F., B.t.u.	A	2.843	3.043	3.755
	B	0.235	0.257	0.281
	C	2.608	2.786	3.474
Saving of bare pipe loss, per cent		91.8	91.6	92.5

Cover No. 2		Test No. 1	Test No. 2	Test No. 3
Gage pressure, lb. per sq. in.		53.9	109.2	256.3
Temperature of steam, deg. F.		301.3	343.5	408.0
Temperature of air, deg. F.		64.4	66.2	72.8
Temperature of cover, deg. F.		98.9	99.8	112.8
Difference between steam and air temperature		236.9	277.3	335.2
Loss per square foot per hour per deg. difference of temperature deg. F., B.t.u.	A	2.854	3.056	3.601
	B	0.431	0.463	0.525
	C	2.423	2.593	3.076
Saving of bare pipe loss, per cent		84.9	84.9	85.5

*Abstract of National Physical Laboratory Report, Apr. 26, 1910.

Hydro-Electric Development Will Utilize 1,900-Foot Fall of Water

In a recent address before the Stockton Rotary Club, Samuel Kahn, vice president and general manager of the Western States Gas and Electric Co., referred to the additional 30,000-hp. hydro-electric development planned by his company. The new developments, which are located on the south fork of the American River, a few miles above the company's present hydro-electric development, include the construction of a reservoir for impounding waters in the Twin Lakes, Echo and Medley lakes at the headwaters of the south fork of the river.

As small dams were in existence at Silver Lake and Echo Lake, no further work was done at these points, but in the summer of 1917 construction was begun on an earth-filled dam with a concrete core wall at Twin Lakes, which was completed in 1918. This dam at the present time is only 8 ft. high, but eventually will be built to a height of 60 ft. In the summer and early fall of 1917 a rubble stone masonry dam was also completed at Medley Lakes. During the years 1918 and 1919 the surveys were still in progress and will probably be completed the early part of 1920.

A connecting ditch originally constructed for a capacity flow of 80 cu.ft. per sec. will be enlarged to carry 250 or 300 cu.ft. per sec. Furthermore, it may be lined with pre-cast concrete slabs to reduce friction losses and to minimize ice troubles, as during midwinter there are periods when the ditch freezes.

After the water flows down the ditch for a distance of 24½ miles, it will reach a proposed forebay and the waters from this forebay will be conducted through a high-pressure pipe line about 2½ miles in length, which will terminate in the south fork of the American River in the vicinity of Long Canyon. The difference in elevation between the proposed forebay and the proposed plant is 1,900 ft., which will make it one of the high-head developments of the country and, in fact, of the world. The pipe line will be constructed of wood and steel; that is to say, the upper end of the pipe line, where the pressure is relatively small, will be constructed of redwood staves, which have been found to be excellent for such purposes. The lower end of the pipe will be built of steel of varying thicknesses, the heaviest pipe, of course, being at the bottom of the canyon. As a matter of fact, the lower sections of the pipe will have to be constructed of the highest-grade steel and lap-welded to withstand a working pressure of 800 lb.

After the water passes through the proposed hydraulic plant, it will again flow down the American River several miles until it reaches the present dam and diversion, where it will be picked up again and used in the present plant. After the water has passed this plant, it will be used farther down stream again for irrigation and domestic purposes.

It is reported that there are thirteen sources of water power in Ceylon, which if developed would generate approximately 500,000 hp. Since the present demand for power is only 60,000 to 70,000 hp., it has been decided that only the Laxapana and Dickoya Rivers be exploited, as they would supply about 200,000 hp.—*London Electrical Review.*

New Publications

THE COAL CONSUMPTION OF POWER PLANTS AND BONUSES FOR COAL SAVING. By Robert H. Parsons. Published by the Electrical Review, London, England. Pamphlet; 8½ x 5½ in. 23 pages. Price 1 shilling.

The author sets forth some methods of establishing and utilizing standards of power-plant efficiency and describes bonuses for power-plant employees. The reader will perhaps get an idea of what the booklet contains by being advised that its contents is made up of text and charts like those in the paper by R. J. S. Pigott, "Graphic Analysis of Power Plant Performance," before the American Society of Mechanical Engineers a few years ago, though not as complete or detailed as Mr. Pigott's paper.

Obituary

Pierrepont Bigelow, who succeeded his father, Col. F. L. Bigelow, when the latter died a couple of years ago, as treasurer of the Bigelow Co., New Haven, Conn., died suddenly of pneumonia on Jan 28. Mr. Bigelow was 32 years old. He was a graduate of Sheffield Scientific School, a man of sterling qualities and high ideals, and had a good mechanical mind.

E. Fred Wood, formerly vice-president of the International Nickel Co., died suddenly at New York City on Jan. 5. Mr. Wood was born in Milwaukee on Aug. 28, 1858. He was educated in the public schools of his native city and later entered the University of Michigan, from which he was graduated. After leaving college he devoted himself to the study of metallurgy and in connection with his studies made extensive trips through the various mining camps of the West and lived for a year at Leadville and other mining towns, where he pursued his studies and obtained his practical experience. He later entered the employ of the Carnegie Steel Co. and rapidly rose to the position of assistant general superintendent of the Homestead plant, which position he filled for a number of years. During the period of the big strike at the plant, when Mr. Frick was shot, Mr. Wood was in entire charge of the plant. He was looked upon by Mr. Carnegie and his associates as one of the valuable men of the organization and was one of the so-called "Carnegie Veteran Associates." He was invited to join the International Nickel Co. upon its organization, becoming first vice-president of the company and a member of the board of directors and of its executive committee. He was an important factor in developing the mining, smelting and refining business of the company. When the United States entered the world war Mr. Wood resigned his official connection with the nickel company to devote himself to public work, and became a member of the Committee on Production of the War Industries Board. He served on this board during the entire period of the war without compensation and his work was fine and of inestimable value and won the admiration and commendation of those who were brought into contact with it. He was a member of the University of Michigan Club, the Automobile Club, the New York Athletic Club, the Society for Electro-Chemical Engineers, and the Railroad Club. He is survived by his widow and one daughter.

Personals

C. H. Gustafson, formerly with the St. Louis & San Francisco R. R. at Springfield, Mo., is now superintendent of motive power for the Wichita Falls, Ranger & Fort Worth Railroad.

A. S. Winter, formerly advertising and sales manager for the Wm. Powell Co., has joined the sales force of the Fairbanks Co., of Pittsburgh, Penn., and will represent the company in southern Ohio.

J. G. Miles has been appointed supply division manager of the Westinghouse Electric and Manufacturing Co.'s Seattle office, to succeed C. V. Aspinwall, now the company's representative at Spokane, Wash.

D. D. Tripp, vice president of the Pioneer Rubber Mills, San Francisco, has left for an extended trip through the Orient, to be gone six or eight months, to study the great possibilities for sales development in the East.

Hjalmar E. Skougor, who has been connected with Guggenheim Bros., Chile Exploration Co. and Braden Copper Co. for the last seven years as designing engineer, has severed his connection with these companies to return to private practice as consulting industrial engineer, with offices at 120 Broadway, New York City.

A. M. Quick, of Baltimore, Md., and Howard P. Quick, of New York City, consulting hydraulic power-plant engineers, are associated in the design and construction of a hydro-electric plant on the Shenandoah River, near Front Royal, Va., in connection with some industrial plants which have been under way for a year or more, having received special war grants for this work.

Lewis E. Ashbaugh, hydraulic engineer with the J. G. White companies and clients for the past twelve years, is now sales engineer at the New York office of John R. Proctor, Inc., of Bayonne, N. J., in charge of fuel-oil installations and other electrical equipment for power and lighting purposes.

Paul Wunderlich, consulting industrial engineer, will leave shortly for Japan as mechanical engineer for the George A. Fuller Co. He is endeavoring to get up a complete catalog and data file of mechanical, electrical and sanitary equipment, and will appreciate literature of this kind sent to him in duplicate, in care of the Geo. A. Fuller Co., Flatiron Building, New York City.

Aubrey G. Haven, Brooklyn, N. Y., has been appointed real estate engineer in charge of the valuation of right of way and real estate for the Gulf, Mobile & Northern R. R. Mr. Haven was for over five years with the Interstate Commerce Commission engaged on land valuations, and prior thereto was engaged on real estate appraisals for numerous other railroads.

Engineering Affairs

The American Society of Mechanical Engineers, St. Louis Section, will hold a meeting on Mar 19, at which P. E. Irvine will talk on the "New By-Product Coke Plant at Granite City."

The Engineers' Club of Philadelphia will hold a special meeting on Feb. 28, at which will be presented a "Report of Joint Conference of Committee on Development of the Four Founder Societies."

The American Society of Mechanical Engineers, Buffalo Section, will hold a meeting under the auspices of the Engineering Society of Buffalo on Feb. 24. A. L. De Leeuw will speak on the subject of "Wage Payments."

The Indiana Engineering Society, at the annual convention held in January elected the following officers: President, W. T. Titus, Indianapolis; vice president, O. C. Ross, Indianapolis; secretary, Charles Brossman, Indianapolis; trustees: D. D. Ewing, LaFayette; A. P. Melton, Gary; John W. Fulwider, Lebanon; Frank C. Wagner, Terre Haute; Edwin S. Pearse, Indianapolis.

Business Items

The Tacony Steel Co. is opening a Chicago sales office in the Marquette Building, with Frank B. Hillwick, until recently with the Crucible Steel Co., as district sales manager.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$8.20@$8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	3.60@ 3.80
Rice	2.30@ 2.50
Barley	1.25

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.85@$3.25	$3.15@$3.60
F.o.b. Philadelphia, gross tons	5.05@ 5.60	5.35@ 5.90
F.o.b. New York, gross tons	5.40@ 5.95	5.75@ 6.25
Alongside Boston (water coal), gross tons	7.00@ 7.75	7.60@ 8.60

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite

	Company Coal
Broken	$7.80@$8.25
Egg	8.20@ 8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	5.15
Rice	4.50
Barley	4.85
Boiler	4.85

Bituminous

Government prices at mines:	Spot
South Fork (best)	$3.25@$3.50
Cambria (best)	3.00@ 3.25
Cambria (ordinary)	2.60@ 2.90
Clearfield (best)	3.00@ 3.25
Clearfield (ordinary)	2.60@ 2.90
Reynoldsville	2.85@ 2.90
Quemahoning	3.25@ 3.50
Somerset (medium)	3.00@ 3.25
Somerset (poor)	2.50@ 2.75
Western Maryland	2.50@ 2.75
Fairmont	2.25@ 2.50
Latrobe	2.60@ 2.90
Greensburg	2.75@ 3.00
Westmoreland ¾ in.	3.40@ 3.50
Westmoreland run-of-mine	2.75@ 3.00

PHILADELPHIA—Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.55; lump, $3.00@$3.35, at the mines.

BUFFALO—

Anthracite

	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8.55	$10.80
Egg	8.80	10.65
Stove	9.00	10.85
Chestnut	9.10	10.85
Pea	7.75	9.30
Buckwheat	5.70	7.75

Bituminous

Allegheny Valley	$4.80
Pittsburgh	4.65
No. 8 Lump	4.65
Mine Run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite

Egg	$12.25@$12.40
Chestnut	12.50@ 12.70
Grate	12.25@ 12.40
Stove	12.40@ 12.60

Pocahontas

Mine-run	$7.50

Domestic Bituminous

West Virginia split	$8.50
No. 8 Pittsburgh	$6.00@ 6.90
Massillon lump	8.25@ 8.50
Coshocton lump	7.15

Steam Coal

No. 6 slack	$5.25@$5.50
No. 8 slack	5.10@ 5.30
Youghiogheny slack	5.25@ 5.50
No. 8 ¾ in.	5.70@ 6.00
No. 6 mine-run	5.25@ 5.50
No. 8 mine-run	5.75

Only coal available is mine-run Pocahontas

MIDDLE WEST—Chicago quotations, F.o.b. cars at mine:

	Springfield, Carterville, Williamson, Franklin, Saline, Harrisburg	Fulton, Peoria	Grundy, La Salle, Bureau, Will
Lump	$2.55@$2.70	$2.95@$3.10	$3.25@$3.40
Washed	2.75@ 2.90		3.45@ 3.60
Mine run	2.35@ 2.50	2.75@ 2.90	3.00@ 3.15
Screenings	2.05@ 2.20	2.35@ 2.50	2.75@ 2.90

New Construction

PROPOSED WORK

Mass., West Springfield (Springfield P. O.)—McClintock & Craig, Archts. and Engrs., 33 Lyman St., Springfield, will receive bids for the construction of a 1 story power house on Cold Springs Ave., for the Gilbert & Barker Mfg. Co.

Conn., Hartford—Bryant & Chapman, Woodland St., plan to construct a power plant. C. N. Flagg & Co., State St., Meriden, Engrs.

Conn., Hartford—A. Goldstein is having preliminary plans prepared for the construction of a 2 story, 101 x 119 ft. garage on Maple Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. F. Walz, 348 Trumbull St., Archt.

Conn., Hartford—The Hartford Electric Light Co., Pearl St., plans to build a power plant at South Meadows. E. F. Lawton, Genl. Mgr.

Conn., Hartford—E. M. Stone, Engr., 327 Trumbull St., is having preliminary plans prepared for the construction of an office building at 55 Pratt St. A sprinkler and vacuum cleaning system will be installed in same. Owner's name withheld.

Conn., Meriden—The Mt. Carmel Italian Roman Catholic Church, Springfield Ave., c/o D. Ricca, Pastor, is having preliminary plans prepared for the construction of a church on Springfield Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. Mardietti & D'Avina, 756 Main St., Hartford, Archts.

Conn., West Hartford—Ford, Buck & Sheldin, Engrs., 60 Prospect St., will receive bids about March 1 for furnishing and installing a steam heating plant including 125 lb. pressure H.R.T. boilers and 20,000 sq. ft. radiation for the Amer. School for the Deaf, 65 Garden St., Hartford. Total estimated cost, $60,000.

N. Y., Buffalo—The Bison Ice & Coal Co., Inc., plans to construct a 2 story branch ice plant at 200-216 Rapin Pl. Ice making equipment will be installed in same. Total estimated cost, $50,000.

N. Y., New York—The Bellevue & Allied Hospital, New York City, received bids for the installation of boiler pumps, etc., in the new boiler plant at the Fordham Hospital, from Chute, Thornton & Bailey Corp., 2 East 13th St., $36,500; Kings Co. Heating & Ventilating Co., 40 Boerum Pl., $38,750; Johnson Heating Co., $46,524, all of New York City.

N. Y., New York—M. E. Connelly, Pres. of Queens Boro, received bids for the construction of an automatic electric pumping station on Genesee St., from Fox & Renalls, 87 East 125th St., $177,281; J. L. Stegretto 6103 18th Ave., $224,000; Ajax Drainage Const. Corp., 60 Herkimer St., $227,000.

N. Y., New York—The Kelly Springfield Tire Co., 200 West 57th St., is having plans prepared for the construction of a 17 story, 100 x 104 ft. office building on 7th Ave. and 57th St. A steam heating system will be installed in same. Total estimated cost, $2,000,000. E. Necarsulmer, 507 5th Ave., Engr.

N. Y., New York—The Western Electric Co., 195 B'way, is having plans prepared for the construction of an 8 story, 200 x 325 ft. warehouse on Hudson, West Houston and Greenwich Aves. A steam heating system will be installed in same.

N. Y., New York—Zipkes, Wolff & Kudroff, Archts. and Engrs., 25 West 42nd St., is preparing plans for the construction of a factory. A steam heating system will be installed in same. Total estimated cost, $150,000. Owner's name withheld.

N. J., Pennsville—Charles R. Peddle, Archt., 136 South 4th St., Philadelphia, Pa., will receive bids in a month for the construction of a 2 story, 75 x 125 ft. school in Salem Co., for the Bd. Educ. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Johnstown—M. Lee Masterson, Supt. of Highways, will soon award the contract for the furnishing, setting up and erecting in place ready for service on ground owned by city, one 800 sq. yd., 3 unit asphalt plant, one 3,000 gal. portable steam melting kettle, 1 combination 40 hp. boiler with 25 hp. engine and one 5 ton tendem steam or motor roller. Bidders asked for prices with or without approved air lift and running trucks for any and all of said equipment.

Pa., Philadelphia—Meubauer & Supourtz, Archts., 929 Chestnut St., will soon award the contract for the construction of a 1 story, 92 x 100 and 36 x 115 ft. garage on Belfield Ave. and Broad St., for the Crosstown Realty Co. A steam heating system, pumps and tanks will be installed in same. Total estimated cost, $35,000.

Pa., Philadelphia—Stewartson & Page, Archts., 318 Walnut St., will soon receive bids for the construction of a 4 story addition to hospital for the Children's Hospital, 18th and Fitzwater Sts. A new power plant will be installed in same. Total estimated cost, $100,000. Noted Aug. 26.

Pa., Scranton—The Scranton Gas & Water Co., 115 Wyoming Ave., will soon award the contract for the construction of a 3 story, 80 x 100 ft. office building. A steam heating system will be installed in same. Total estimated cost, about $200,000. Edward H. Davis and George M. D. Lewis, Union Natl. Bank Bldg., Archts.

Pa., Shickshinny—The First Natl. Bank plans to construct a 3 story, 50 x 100 ft. bank on Main and Union Sts. A steam heating system will be installed in same. Total estimated cost, $100,000.

Va., Roanoke—The Bd. Educ. is having plans prepared for the construction of a 3 story high school on Park St. A steam heating system will be installed in same. Total estimated cost, $450,000. H. C. Richards, 1713 Sansom St., Philadelphia, Archt.

O., Cleveland—The city plans to construct a 2 story police station on East 37th St. and Orange Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. F. H. Betz, 601 City Hall, Archt.

O., Cleveland—The City Club of Cleveland, c/o Francis Hayes, Hollenden Hotel, plans to purchase a site and build a club house on same. A steam heating system will be installed in same. Total estimated cost, $200,000.

O., Cleveland—The Cleveland Electric Illuminating Co., 75 Public Square, is having plans prepared for the construction of a 1 story boiler house at the foot of East 70th St. S. M. Gallagher, 408 Illuminating Bldg., Engr. Total estimated cost, $100,000.

O., Cleveland—W. S. Ferguson Co., Archts., 1900 Euclid Ave., will receive bids about Feb. 26 for the construction of a 6 story, 100 x 200 ft. commercial building on East 61st St. and Euclid Ave., for G. A. Tenbush, Union Bldg. A steam heating system will be installed in same. Total estimated cost, $400,000.

O., Cleveland—W. S. Ferguson Co., Archts., 1900 Euclid Ave., will soon award the contract for the construction of a 2 story, 75 x 100 ft. factory on Payne Ave. and East 37th St. for the Amer. Register Co., 403 Long Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

O., Cleveland—St. George's Church, c/o J. E. Potter, Archt., 947 Leader-News Bldg., is having plans prepared for the construction of a 2 story, 90 x 140 ft. school at East 67th and Superior Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

O., Cleveland—St. Paul's Episcopal Church, Rev. Walter R. Breed, pastor, East 40th St. and Euclid Ave., plans to construct a 1 story church. A steam heating system will be installed in same. Total estimated cost, $200,000.

O., Cleveland—The Second Presbyterian Church, c/o Rev. Paul F. Sutphen, pastor, 2525 Stratford Ave., plans to build a 1 story church. A steam heating system will be installed in same. Total estimated cost, $100,000.

O., Cleveland—The Cleveland Railway Co., Leader-News Bldg., plans to construct a 1 story power sub-station near East 105th St. and Euclid Ave. Estimated cost, $200,000. Mr. Radcliffe, Mgr. L. P. Crocelius, 700 Leader-News Bldg., Engr.

O., Shaker Heights (Cleveland P. O.)—The Bd. Educ., Carl A. Palmer, 10111 Euclid Ave., Cleveland, plans to construct a 2 story grade school. A steam heating system will be installed in same. A $300,000 bond issue has been passed for this project.

Ind., Gary—The Co. Comrs. will soon receive bids for the construction of a tuberculosis sanitarium including a boiler house, etc., for Lake Co. A high pressure steam heating system will be installed in same. Total estimated cost, $300,000.

Mich., Benton Harbor—The Congregation of Good Samaritan, c/o H. S. Gray, 8-10 Sonner and Gray Bldg., plans to build a 2 story community house. Steam heating equipment will be installed in same. Total estimated cost, $100,000.

Mich., Detroit—The Dept. of Pub. Wks. will soon award the contract for the construction of a 2 story, 58 x 121 ft. steam power building and a 190 ft. brick stack for heating city buildings, on Macomb and Clinton Sts. A 150 kw. motor generator set, two 300 hp. boilers and one 600 hp. water tube boiler and a battery set providing for 2 more will be installed in same. John Scott & Co., 2326 Dime Bank Bldg.. Archt. Esselstyn, Murphy & Hanford, 810 Marquette Bldg., Engrs.

Mich., Detroit—The Detroit Lodge, Loyal Order of Moose, 40-43 Congress St., plans to construct a 3 story lodge temple on Cass Ave. and Elizabeth St. A steam heating system will be installed in same. Total estimated cost, $500,000.

Mich., Lansing—The Novo Engine Co., 702 Porter St., plans to construct a 1 and 2 story foundry on Porter St. Electric motor for power and probably a hot blast heating system will be installed in same. Total estimated cost, $250,000.

Mich., Pontiac—The Oakland Co. Bd. Supervs. plan to build a 3 story, 46 x 176 ft. jail addition on Wayne and Warren Sts. A steam heating system will be installed in same. Total estimated cost, $275,000. F. D. Madison, Royal Oak, Archt.

Ill., Chicago—The Commonwealth Edison Co., 72 West Adams St., plans to construct a power plant in the Calumet Dist. Plant will be largest in their system, having a capacity of over 185,000 kva. Total estimated cost, $10,000,000 to $12,000,000. Marshall & Fox. 721 North Michigan Ave., Archts. Sargent & Lundy, 72 West Adams St., Engrs.

Ill., Chicago—The Kewance Boiler Co. is having preliminary plans prepared for the construction of a 10 story, 100 x 100 ft. salesroom and warehouse on Washington and Green Sts. A steam heating system will be installed in same. Total estimated cost, $500,000. S. N. Crowen, 30 North La Salle St., Archt.

Wis., Menomonee Falls—The Farley Candy Co., 720 North Franklin St., Chicago, Ill., plans to build a 1 story, 300 x 800 ft. chocolate factory. Steam heating and electric power will be installed in same. Total estimated cost, $300,000.

Wis., Sheboygan—The Mikadon Amusement Co., 1110 Washingon St., is having plans prepared for the construction of a 1 story, 70 x 200 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $100,000. Stanley F. Kadow, 451 Mitchell St., Milwaukee, Archt.

Ia., Davenport—Roy France, Archt., Chicago, Ill., will soon receive bids for the construction of an 8 story, 128 x 152 ft. apartment hotel on 6th and Brady Sts., for the Hillcrest Apartment Hotel Co. A complete refrigeration system will be installed in same. Total estimated cost, $ 00,000. Clausen & Kruse, 316 Central Office Bldg., Engrs.

Ia., Des Moines—R. E. Bales, Secy. Executive Council, State House, plans to build a 5 story, 65 x 175 ft. heating plant and warehouse with an 80 x 80 ft. wing, on the capitol grounds. Heating contract will be sub-let. Total estimated cost, $400,000. Canfield Eng. Co., 406 Flynn Bldg., Engrs.

Ia., Washta—J. K. McGonigae, Secy., will receive bids until March 16 for the construction of a 3 story, 58 x 102 ft. school. A steam heating system will be installed in same. Total estimated cost, $100,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Archt.

Kan., Arkansas City—The city is having plans prepared for the improvement of the waterworks system, including distributing reservoir and power unit for pumps and meters. Total estimated cost, $61,000. E. B. Wilkinson, Engr.

Kan., Coats—The city is having plans prepared for the construction of an electric transmission line from here to Pratt, a distance of 13 miles. Estimated cost, $24,000. G. L. Wright, Clk. W. B. Rollins & Co., 209 Ry. Exch. Bldg., Kansas City, Mo., Engrs.

Kan., Emporia—The State, c/o J. A. Kimball, will receive bids for the construction of a 1 story power plant. Estimated cost, $70,000. R. S. Gamble, 1415 Fillmore St., Topeka, Engr.

Mont., Dillon—Beaverhead Co. plans an election to be held April 23 to vote on $50,000 bonds for the construction of a central heating plant for county courthouse, high school, dormitory and other county buildings. W. E. Chapman, Co. Engr.

Mont., Helena—The Lewis & Clark Helena Valley Irrigation Project plans to irrigate 40,000 acres by means of 45 miles of canals, and the purchase of 2 pumping plants now in operation. Total estimated cost, $600,000. A. W. Verharen, 18 Kohrs Bldg., Engr.

Okla., Anadarko—The city voted $75,000 bonds to improve electric system and is in the market for Diesel engines to replace steam equipment.

Ore., Scio—The city plans to construct a cyclopean or rubble masonry dam flume and timber headgate, taking 47 second ft. of water from Thomas Creek, for pumping, light and power plant. Estimated cost, $38,427. A. G. Prill, mayor.

Ore., Wasco—H. S. Wall filed an application with P. A. Cupper, State Engr., Salem, for 500 second ft. of water to be taken from the John Day River near Early for the development of 600 hp. plant. Applicant will construct a canal, 20 ft wide, and install a turbine water wheel. Total estimated cost, $57,150.

Cal., San Diego—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until March 1 for furnishing and installing complete power plant and electric generating equipment including distribution systems for electricity and steam at the Marine Corps Base, here. Noted Feb. 9.

Alaska, Petersbury—The city voted $75,000 bonds, $25,000 of which is to be used for the construction of a light and power plant and $50,000 for the construction of a 2 story school house. Noted Oct. 14.

Alaska, Port Chatam—The Pacific Sea Products Association, Seattle, Wash., plans to build a 2 story cold storage plant to have a 2,000,000 lb. capacity. Estimated cost, $100,000. O. O. Hytum, Pres.

Ont., Belleville—The Bd. Educ. plans to construct a 3 story collegiate building. A vacuum steam heating system will be installed in same. Total estimated cost, $350,000. A. McGil, Chmn.

Ont., Courtright—The town passed a $20,000 by-law for the construction of a waterworks system including deep wells, pumping machinery, pump house, mains, steel tank, etc. R. G. Stewart, Clk.

Ont., Dresden—The taxpayers authorize an expenditure of $20,000 for the construction of waterworks system including deep wells, pumps, pump house and mains. Address J. T. Budgewater, Clk.

Ont., Sault Ste Marie—The School Bd. plans to build an addition to present high school and a 2 and 3 story technical school. A vacuum steam heating system will be installed in same. Total estimated cost, $112,000.

Ont., Toronto—The St. Clair Ave. Methodist Church, c/o F. L. Barker, 18 Oriole Gardens, plans to build a 1 story church. An electric operated organ and hot air heating system will be installed in same. Total estimated cost, $125,000.

Ont., Weston—The town plans to install a gasoline driven fire pump as a standkey, 750 imp. gal. pump against about 300 ft. head-3 stage driven by a 150 hp. marine engine. Estimated cost, between $8,000 and $10,000. E. A. James Co., 36 Toronto St., Toronto, Engr.

Ont., Windsor—The Border Cities Hotel Co. is having plans prepared for the construction of a 10 story hotel on Ouellette Ave. A vacuum steam heating system will be installed in same. Total estimated cost, $1,000,000. F. L. Howell, 17 Ouellette Ave., Secy. and Treas. Esenwein & Johnson, Ellicott Sq., Buffalo, N. Y., Archts.

CONTRACTS AWARDED

R. I., Providence—The Eastern Terminal Corp., 103 Federal St., New London, Conn., has awarded the contract for the construction of a 280 x 500 ft. cotton warehouse on Springfield Ave., to the Aberthaw Constr. Co., 27 School St., Boston, Mass. A steam heating system will be installed in same. Total estimated cost, $200,000.

N. Y., Brooklyn—The Standard Oil Co., 26 B'way, New York City, has awarded the contract for the construction of a 1 story, 50 x 90 ft. power house on Calyer and Kingsland Aves., to C. C. Woodruff, 213 10th St., Long Island City. A steam heating system will be installed in same. Total estimated cost, $26,000.

N. Y., Buffalo—The Philadelphia Rubber Co., 37th and Reed Sts., has awarded the contract for the construction of two 1 and 3 story factory, office, garage and buildings, including power house, to the Austin Co., 16112 Euclid Ave., Cleveland, O. Total estimated cost, $1,000,000.

N. Y., New York—The Bowman Realty Co., 225 West 49th St., will build a 4 story, 100 x 200 ft. garage on B'way between 131st and 132nd Sts. A steam heating system will be installed in same. Total estimated cost, $330,000. Work will be done by day labor.

N. Y., New York—The Fiske Rubber Co., Chicopee Falls, Mass., has awarded the contract for the construction of a 20 story, 64 x 150 ft. office building at 1765 B'way, to Fred T. Ley Co., 19 West 44th St. A steam heating system will be installed in same. Total estimated cost, $3,000,000.

N. Y., New York—The Natl. Park Bank, 432-434 Madison Ave., has awarded the contract for altering bank and office building, to Marc. Eidlitz, 30 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $600,000.

N. J., Plainfield—S. Schwartz, 220 B'way, New York City, has awarded the contract for the construction of a 2 story, 100 x 150 ft. theatre on Front St. and Waterbury Ave., to M. Shapiro, 52 Vanderbilt Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $250,000.

Pa., Philadelphia—The Evening Bulletin, Juniper and Arch Sts., has awarded the contract for the construction of a 7 story, 87 x 147 ft. office building addition, to Doyle & Co., 1519 Sansom St. Contract for installation of a steam heating system will be sub-let. Total estimated cost, $500,000. E. V. Seller, 101 Juniper St., Archt.

D. C., Washington—Frank C. Lewen, c/o Carrere & Hastings, Archts., 52 Vanderbilt Ave., New York City, will build a 12 story, 200 x 200 ft. hotel, here. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

O., Cleveland—The Hydraulic Pressed Steel Co., Hydraulic Ave., has awarded the contract for remodeling the 1 story heat treating plant on Hydraulic Ave. to E. R. Russell, Sincere Bldg. Estimated cost, $10,000.

Ind., Indianapolis — The Indianapolis Power & Light Co. has awarded the contract for the construction of a 1 story power extension to H. K. Ferguson Co., 1532 Euclid Ave., Cleveland, O. Estimated cost, $75,000.

Mich., Detroit—The Amer. Electrical Heater Co., Woodward and Burroughs Sts., has awarded the contract for the construction of a 1 story, 60 x 417 ft. factory and boiler house on Commer and Dequindre Sts. to Conral Keller, 210 Moran St. One boiler will be installed in same. Total estimated cost, $35,000.

Ill., Chicago—Linstrom Smith & Co., 1101 South Wabash Ave., has awarded the contract for the construction of a 1 story, 130 x 250 ft. factory on Lake St. and Kedzie Ave., to Jacob Rodatz, 209 South La Salle St. A steam heating system will be installed in same. Total estimated cost, $125,000.

Wis., Milwaukee—The Westinghouse Lamp Co., 165 B'way, New York City, has awarded the contract for the construction of a 4 story factory addition, to Stone & Webster, 120 B'way, New York City. A steam heating system will be installed in same. Total estimated cost, $400,000.

Wis., Sheboygan—The Vollrath Co., North Michigan Ave., has awarded the contract for the construction of a 1 story power plant, to the Westinghouse, Church Kerr Co., Inc., 37 Wall St., New York City. A steam heating system will be installed in same. Total estimated cost, $200,000.

Minn., New Ulm—The Eagle Rolling Mill Co. has awarded the contract for furnishing rolling equipment, including boilers, crane and coal handler, to J. G. Robertson, 2542 University Ave., St. Paul. Total estimated cost, $35,000.

Minn., Minneapolis—The Bd. Educ. has awarded the contract for installing a heating system in the proposed 1 story, 60 x 194 ft. addition to the Whitney School, on 19th Ave., N. E., to Bjorkman Bros., 712 10th St. South, at $20,004.

Minn., Minneapolis—The Bureau of Buildings, Bd. Educ., has awarded the contract for installing a steam heating and ventilating system in the proposed 3 story, 61 x 163 ft. addition to Calhoun School, on Girard Ave., to H. Kelly & Co., Plymouth Bldg., at $58,597.

Kan., Cheney—The city has awarded the contract for installing pumps in connection with the waterworks system, to Lutweiler Pump Co., Rochester, N. Y., at $4,000.

Kan., Independence—The Commercial Natl. Bank has awarded the contract for the installation of a heating system in the proposed 6 story, 70 x 140 ft. bank, to the Sell Orr Co., Independence. Total estimated cost, $150,000.

Wyo., Casper—The city has awarded the contract for the construction of a watergallery in the bed of the Platte River at pumping station intake and for the revision of pump station buildings, hauling and setting up machinery, to W. F. Henning, $47,650. A semi Diesel internal combustion engine will be installed in same.

Tex., Abilene—The Abilene Gas & Electric Co. has awarded the contract for the construction of a new central station to the W. C. Hedrick Constr. Co., Southwestern Life Bldg., Dallas, at $110,000.

Tex., Longview—The Longview Ice & Light Co. has awarded the contract for the construction of a new ice plant, to the W. C. Hedrick Constr. Co., Southwestern Life Bldg., Dallas. Estimated cost, $50,000.

NEW INSTALLATIONS IN POWER

Conn., Hartford—Wise & Npson, 36 Pearl St., is in the market for ½ yd. electric driven concrete mixer and a 50 hp., 3 ph., 220 volt, 60 cycle double drum electric hoist.

N. Y., Long Island City—The Metal Stamping Co., 13th St. and East Ave., is in the market for a steam driven air compressor, to have a 1,200 cu. ft. capacity and inclinable presses.

N. Y., Norwich—The New York State Gas & Electric Corp. plans to construct a 10 unit, 3 ph. transmission line from here to Oxford and install a new Skinner generating unit. O. E. Wessel, Mgr.

Pa., Gouldsboro—H. C. Reiling is in the market for two 60 hp. steam boilers, one 35 hp. steam engine and 1 dynamo.

Pa., Philadelphia—The Philadelphia & Reading R. R., 11th and Market Sts., is in the market for complete electrical power house equipment to replace present equipment in the 1119 Arch St. power house, also for air compressors, ditchers, wrecking crane and radiator valves.

Pa., Pittston—Thomas W. Bentley is in the market for 100 5hp. electric motors.

N. C., Moravian Falls—The Moravian Falls Milling & Power Co. plans to install a new turbine generator, etc. J. T. Humphries, Mgr.

Mich., Milford—The Milford Electric Co. plans to construct a transmission line through the country reaching 4 villages and to install motors and transformers and have further development to water power. F. S. Hubbell, owner.

Wis., Milwaukee—Robert L. Deisinger & Co., 913 1st Natl. Bank Bldg., is in the market for a 16 hp. hoisting engine.

Wis., Rome—The Bark River Electric Service Co. plans to construct a 20 mi. transmission line. A. N. Becker, Supt.

Minn., Alberta—The Southern Minnesota Gas & Electric Co. plans to install a 300 hp. boiler and construct a 40 mi., 13,200 and 6,600 volt transmission line. H. L. Nickels, Pres. and Mgr.

Minn., Sunrise—The Sunrise Milling & Electric Co. plans to construct a 25 mi. new 6,600 volt transmission line. F. A. Spivak, Engr.

Kan., Hanover—The Hanover Municipal Electric Light, Power & Water Plant plans to install a 325 kva. hydro-electric plant on the bank of the Little Blue River. Estimated cost, $75,000. Ray C. Walker, Chief Engr.

Neb., McCook—The McCook Electric Co. plans to install one 500 kva. turbo condensing generator. Alex. Speer, Secy. and Mgr.

Mont., Mansfield—The Mansfield Light & Power Co. plans to install a generating engine. Walter C. Coday, Mgr.

Okla., Laverne—Laverne City Light Dept. plans to install 2,400 volt alternators and transformers. Claude H. Arbuthnot, Supt.

Ore., Keno—The Keno Power Co. plans to construct a 6 mi. transmission line and install a 800 hp. turbo unit. J. W. Kerns, Pres. and Mgr.

P. R., Arecibo—The Municipal Electric Light Plant plans to construct an extension to transmission lines and install a 75 kw. generator and a 100 hp. Mietz & Weiss engine. J. M. Ginzaley, Supt.

Ont., Campbellford—The Municipal Electric Light Plant plans to increase transmission voltage to 6,600 in order to supply additional hp. to one of its present power users. J. F. McGregor, Acting Secy.

Ont., Ottawa—The Mortimer Co., 259 Sparks St., is in the market for one 15 hp. d.c. 500 volt motor compound wound, speed not more than 1,200 r.p.m.

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